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ANTECEDENTS OF GREEK CORPUSCULAR THEORIES

BY WILLIAM ARTHUR HEIDEL

IN a measure hardly realized the character and direction of occidental thought have been predetermined by that of Greece. In studying the history of ideas it is customary to start with those of the Greeks, and many scholars have devoted themselves to the task of tracing their development; but it must be confessed that the results are somewhat disappointing. It may be desirable, therefore, before beginning our special inquiry, to consider the attitude of the historians of Greek thought, since by so doing we may at least arrive at an intelligent view of the method to be pursued in such studies.

The history of Greek thought begins to be a subject of investigation with Aristotle.¹ Of his method of study we can say little except that it was somewhat desultory. His point of view is, however, sufficiently clear. He found next to nothing in the pre-Socratics which had any bearing upon logic and ethics. In metaphysics, and in the special physical and biological sciences, there was a good deal; and this he had more or less roughly tabulated ready to his hand to be used on occasion. It is plainly to be seen that he had wrought out the principles of his philosophy before he wrote any of his extant systematic works. When, therefore, as he proposes some fundamental question, he reviews the opinions of his predecessors, he is guided by a highly abstract and fundamentally metaphysical conception. The occasions on which he is able to discover an exact parallel to his own views are consequently rare; and, what is more important, he not infrequently, though of course without intention, misrepresents the opinions of others by relating them to categories of his own invention. In fields where he was less at home, as for example in those of medicine and mathematics, he delegated the task of gathering the needful data and sketch-

¹ Cf. the interesting sketch of the development of the 'constructive' view of the philosophy of history given by Wundt, *Völkerpsychologie*, Bd. II, Th. I, p. 532 f.

ing the history of ideas to certain members of his school. When Theophrastus wrote his *Φυσικῶν Δόξαι* he did so under the spell of his master's example: the same bias for the abstract and metaphysical points of view is clearly to be seen. Nor was this to be wondered at. In the hey-day of metaphysics, especially of a system of metaphysics like that of Aristotle, so completely articulated that it could for ages enthrall the mind of man, one cannot expect in an enthusiastic adherent of the school an objective judgment; least of all could one hope to find that his unconscious prepossessions had not influenced the selection or rejection of this or the other factor or phase of the thought he was tracing. Every act of selection is determined by interest, and we have seen that the interest of Theophrastus was predominantly metaphysical. We must advert to one other point at which the honest Theophrastus fails us; standing at the beginning of the historical review of Greek thought, he could not see, what to the modern student is strikingly obvious, that there is much more than a golden thread of unity running through the whole pattern. In making his choice of this or that to report, he was guided by the principle of selecting the distinctive doctrines, thus unwittingly creating a false impression when the originals, from which he made the abstract, ceased to be consulted and finally were lost. During the later years of antiquity his abstract, or most commonly extracts from his abstract, were almost the only source of knowledge regarding the history of Greek philosophy to be consulted.

In modern times the interest in the history of Greek philosophy dates from Hegel, who in his turn was again dominated by an enthusiasm for 'logical' or metaphysical thought. Holding that the historical development of ideas conformed of necessity to the steps in the dialectical evolution of reason, he drew attention to a sequence of most abstractly formulated conceptions, overlooking or ignoring the concrete notions or 'Anschauungen' which conditioned or created the logical principles. Although during the last decades historians of Greek thought have in a large measure emancipated themselves from the direct influence of Hegel, the metaphysical bias is still generally to be detected. Those who, like Tannery, Burnet, and Gomperz, have contributed most to the elucidation of the history of ideas, are either anti-metaphysical or come to the study of the subject with a larger interest born of occupation with the general thought of the period.

The day is happily past, or is rapidly passing, when one could profess to write a history of Greek philosophy without taking into account every department of Greek thought and activity. Philosophy was not in ancient days, certainly not in the pre-Socratic period, a study of the closet. Men who were endeavoring to relate the common experience of the race to general principles naturally came into touch with others of like interests, although they might be engaged on less general lines of work. Thus philosophers were from the first associated with mathematicians and physicians, and one and all with men who extended their horizon by travel. Indeed, it is something of an anachronism to make even these distinctions in regard to the earlier 'philosophers': they were quite apt to unite in their persons several or all of these characters. Just as we cannot consider the fifth century philosopher without having regard to Hecataeus and Herodotus and even Thucydides, or, on another side, to the mathematicians and 'Hippocrates': so it is a serious error to take the view that philosophy is to be considered solely in connection with known names, or even that we can determine exactly from whom a particular notion was derived. Although the fifth century B.C. was productive of much literature,¹ it was not really an age of books. The main channels of communication were not yet those of literature; and we can never know or even surmise, except in a few clearly marked instances, whence the inspiration came which prompted this or that development. But a close study of many related problems, if conducted in a broad and enlightened way, must lead in the end to a knowledge of those fundamental notions of concrete things and processes upon which, in the last resort, all philosophy rests. When that stage is reached, it will be time to attempt again a history of Greek philosophy.

Hermann Usener² well said that a people's real development is generally completed when it emerges into the light of history. In the darkness before the dawn it forms the views of life and the conceptions of the concrete facts and phenomena of nature which are destined to

¹ Recent additions to our knowledge of Greek medicine suggest the existence of much literature which is now irretrievably lost. We might have guessed this even from 'Hippocrates.' This is one of the factors which render the problem of the Hippocratean Corpus hopeless of solution.

² *Vorträge und Aufsätze*, p. 110 f.

characterize it during its later career.¹ If it were otherwise the homogeneity of point of view and the consequent individuality of a people, which mark it off from other peoples, would be unintelligible. This is well illustrated by Homer, in whom the Greeks themselves were wont to seek the beginnings of all things.² Such common points of view would naturally not be the subject of discussion. Just because they constituted the presuppositions of all reflection they would be ignored, although they foreshadowed the inferences to be drawn from them. Only when a number of such presuppositions had worked themselves out to their several conclusions, either mutually contradictory or else not obviously related, would critical reflection arise to set the world of thought in order.³ This fact renders the history of ideas difficult. On the one hand, there is a strong temptation to jump to a conclusion, assuming the existence of a conception where it is not, and possibly cannot be; on the other hand, it is possible entirely to overlook a notion which is undoubtedly present. In order to guard against these errors one must take several precautions. One must school oneself to distinguish between primitive ideas, which are never abstract, and derivative ideas, which are progressively abstract. With regard to the latter, the only true course to pursue is to disallow their presence unless the evidence for it is clear and convincing, whereas a truly primitive notion may be safely inferred wherever it serves to elucidate a complex of ideas. In regard to derivative ideas we are often misled by the fact

¹ This holds true also of modern European civilization. Such community of thought in fundamentals as exists between the peoples of Western Europe is due in no small measure to the 'antenatal' assimilation of the civilization of Greece mediated by Rome to that of the northern tribes during the Dark Ages, powerfully reinforced though it was by the influence of the Renaissance.

² I need not say that the practice was often ill-founded. Nevertheless it is true that the organic conceptions on which rested the Greek ethical, religious, and political development in historical times are almost without exception to be found in Homer. Every scholar will have noted this fact in his own peculiar sphere of interest. A few illustrations will be given below.

³ A people dominated by a single idea would perhaps be capable of development, but certainly not of producing a philosophy. It is in some such way that we must explain the history of Hebrew thought, although the Hebrews were, of course, not a people of one idea. Nevertheless, as compared with the Greeks, there is a marked difference in the number of 'motifs' which they developed.

that *we* cannot conceive a given relation without assuming the idea in question. Here a broad study of the problem will often prove that our inability otherwise to conceive of the matter is due to other presuppositions, whereas a different conception was undoubtedly entertained by men who held well considered opinions.¹

The history of Greek corpuscular theories presents a problem of peculiar interest. When one speaks of 'corpuscular theories' one thinks at once of Atomism, although the 'atomic' theory itself was only one of a considerable number of hypotheses propounded in antiquity. When the time comes for a history² of these hypotheses it will be seen that they are in fact closely related, growing in the main out of a complex of primitive conceptions so interwoven with the thought of the Greeks in many spheres that in one form or another they have dominated the philosophy of nature down to our own day. It will be seen also that the particular hypothesis which is properly called Atomism owes its specific character entirely to metaphysical and epistemological considerations, to which are unquestionably due the prominence and preference given to it in the history of philosophy, despite the fact that nearly every distinction upon which it rests has been discarded by modern thought. But we must now turn from these matters to the consideration of the antecedents of the various corpuscular theories.³

Of these the Atomic is best known to us, particularly in the form which it received at the hands of Epicurus. And considering the sad wreck of what of old constituted the superb literature of Greek phi-

¹ Numerous illustrations of this could be cited. I will mention only one. In my *Qualitative Change in Pre-Socratic Philosophy*, *Archiv f. Gesch. der Philos.* XIX (1906), p. 333 f., I called attention to the case of ἀλλοίωσις; other evidence on the same subject will be presented below in connection with the conception of πέψις.

² Mabilleau's *Histoire de la philosophie atomistique*, Paris, 1895, possesses little value; the *Geschichte der Atomistik vom Mittelalter bis Newton* by Kurd Lasswitz, Hamburg and Leipsic, 1890, deals but briefly with Greek Atomism, but is much better. It is not necessary to speak of the treatment of the subject in the comprehensive histories of Greek philosophy.

³ The limits of this paper do not admit of a full discussion of the subject. Here only a few points can be considered in a provisional way. Certain matters were treated of in my paper, *Τὰ ἀναρρητοὶ ὄγκοι of Heraclides and Asclepiades*, *Trans. Amer. Philol. Ass'n*, XL (1910), p. 5 f. I hope later to give a connected account of the whole subject.

losophy, we are peculiarly fortunate in having preserved to us the poem of the Roman Lucretius. In his *De Rerum Natura* he unfolds to us the corpuscular view of the world set forth in order with ample argument and with constant illustrations and applications. His aim, to be sure, is the establishment of the *atomic* hypothesis; but it is obvious even to the casual reader that but a small proportion of his poem deals with the subject matter in a way to exclude the application of his arguments to the uses of almost any corpuscular theory. His manner, moreover, is altogether that of a poet who is aware that he belongs to a noble line which includes Empedocles, Parmenides, and Xenophanes. He appropriates figures from Heraclitus and frankly admires Democritus. Pursuant to the example of his master, Epicurus, he culls illustrations and arguments wherever he can find them. In fact, his poem impresses one as holding much the same position relative to Greek philosophy as does the epic of Vergil to the achievements of his predecessors: whatever there was in them worthy to be enshrined in his verse he appropriated, provided it could be turned to account. The impression of the essential solidarity of the Greek corpuscular philosophy grows upon one as one studies the arguments in detail. We shall therefore avail ourselves of the scheme of Lucretius as a frame for our inquiry, trusting that the event will justify the procedure.

Lucretius begins his exposition (1, 150) with the principle: *nullam rem e nilo gigni diuinitus umquam*. Essentially this is the cornerstone of Greek philosophy, assumed, as Aristotle says, by all Greek physiologists,¹ but apparently first distinctly enunciated by Parmenides.² The proof of this principle Lucretius finds in the fact that everything springs from determinate antecedents, or as he calls them, *semina certa*.³

¹ It is not necessary to quote the passages: *Phys.* 187^a 27, 34; 191^b 13; *Met.* 984^a 29 f.; 1062^b 24; *de Gen. et corr.* 317^b 20. See my *Περὶ Φύσεως*, *Proceedings Amer. Acad. of Arts and Sciences*, XLV, p. 91, n. 49.

² See Zeller, *Philosophie der Griechen*, I^a, p. 411, n. 2; but there is clearly an error in his reference.

³ 1, 159-214; 577-598; 881 ff. Sometimes, but rarely, as 1, 521, the *corpora certa* are definitely conceived of as atomic. In 2, 700 f., they account for the fixed species, that is, for offspring remaining true to type and not proving to be monstrosities; likewise, for the fact that the increments in organic growth maintain the organism in its original shape. Here enters the fact of nutrition, closely allied to *γένεσις*; cf. *cibus* and *certa genetrix*. For *cibus* see 1, 861, and below *passim*.

In a word, as origination (γένεσις) of all sorts is typified by the generation of organic beings, so the fixed species of plants and animals furnish the model for all processes and laws of nature. Obviously this is a primitive conception, though it had become generalized as a logical or metaphysical principle; and we are therefore prepared to find that the same observation was connected with the principle not only by Epicurus, but also by Anaxagoras and Parmenides.¹ Who will doubt that this and kindred observations of the 'natural man' led to the formulation of the postulate?

The converse of this principle Lucretius states 1, 237: *haud igitur possunt ad nilum quaeque reuerti*.² Again the burden of the proof is borne by considerations germane to the *semina certa*. The illustrations are one and all drawn from primitive observations which are known to have engaged the thought of the earliest philosophers.³

The poet next proceeds to show that matter exists in the form of minute particles (1, 265-328). His object is to prove that the slow processes of nature operate by means of corpuscles which, though

¹ Epicurus, apud Diog. L. 10, 38: οὐδὲν γίνεται ἐκ τοῦ μὴ ὄντος. πᾶν γὰρ ἐκ παντὸς ἐγίвет' ἂν σπερμάτων γε οὐδὲν προσδεόμενον. For Anaxagoras see the detailed statement of Simpl. Phys. 460, 4-461, 27. Parmenides, fr. 8, 12: οὐδέ ποτ' ἐκ μὴ ὄντος ἐφήσει πλείους ἰσχύς | γίνεσθαι τι παρ' αὐτό. Nothing but the non-existent can spring from the non-existent! Cf. also Arist. Phys. 196a 31 ff.

² See Lucr. 1, 215-264; 540-550.

³ The essence of the argument is in 225-231:

praeterea quaecumque uertustate amouet aetas, | si penitus perimit consumens materiem omnem, | unde animale genus *generatim* in lumina uitae | reducit Venus, aut reductum daedala tellus | unde alit atque auget *generatim* pabula praebens; | Vnde mare ingenui fontes externaue longe | flumina suppeditant? unde aether sidera pascit? and again in 262 ff.: *haud igitur penitus pereunt quaecumque uidentur*, | quando aliud ex alio reficit natura nec ullam | rem gigni patitur nisi morte adiuta aliena. In these and the intervening verses the poet alludes (*a*) to the conditions necessary to the maintenance of continuous becoming, which Aristotle says Anaximander had sought to provide for by postulating the Infinite as his ἀρχή; (*b*) to the *semina certa*, as already stated, which according to Parmenides would admit only of the birth of the non-existent, if the non-existent were its antecedent; (*c*) to the problem of the μέτρα of the sea, which was settled by Heraclitus, fr. 31; and (*d*) to the process of ἀναθυμίασις, which provides the nutriment for the stars according to all early philosophers and furnishes likewise the model for the κύκλος γενέσεως to all thinkers from Thales onwards.

clearly material, are small beyond human ken.¹ So far as there is any polemic, expressed or implied, it is directed against the Eleatic exclusion of a void, which results in a block universe precluding the possibility of motion, and against the assumption of motion in a plenum.² To the mind of the atomist the twin postulates of atomic corpuscles and of empty space are strictly correlative, each requiring the other by logical necessity. With this argument we are not now concerned. In connection with it, however, Lucretius states that almost all the early philosophers of Greece regarded matter as porous, although like the illustrious Empedocles they made in his opinion shipwreck of their faith by failing to postulate the existence of a void.³ This statement has received far less attention than it deserves; for it is unquestionably true, as our study will show.

It is interesting to note the facts to which Lucretius appeals in seeking to prove the corpuscular constitution of matter. We may here disregard the peculiar nature of the argument, due to the difficulty of defending the assumption that atoms and void together constitute ultimate reality, because the Epicurean regarded the senses, the testimony of which was rather generally impugned by pre-Socratics, as the final court of appeal. The poet, then, begins with a reference to the winds,⁴ which though unseen deal destruction as real as that wrought

¹ The *corpora caeca* are λόγῳ θεωρητά, for (I, 321) *inuida praecludit speciem natura uidendi*. Cf. Plato, *Tim.* 45 E; for Anaxagoras see Arist. *Phys.* 187^a 37 ff., Sext. Empir. 7, 90; and note Hipp. II. ἀρχαῖς ἡγητικῆς, 14 (I, 602 L.): ταῦτα μὲν μεμυγμένα καὶ κεκρημένα ἀλλήλοισι οὔτε φανερά ἐστιν κτλ.

² Probably Lucretius (I, 370 f.) had Aristotle and Plato chiefly in mind; see Arist. *Phys.* 214^a 28 f., Plato, *Tim.* 79 B f. Plato's view is stated in connection with the process of respiration, in which he follows the medical tradition likewise appearing in Empedocles. For Empedocles see Zeller, *Phil. der Griechen*, I b, p. 768, n. 1; for Anaxagoras, *ibid.*, I b, p. 989, n. 3.

³ Lucr., I, 734 f. In *supra quos diximus* he refers to 705 f., where he has mentioned (1) the 'monists' who posited as their ἀρχή, fire (Heraclitus and Hippasus), or air (Anaximenes, Diogenes of Apollonia, and in large part the medical tradition), or water (Thales and Hippo); (2) those who posited ἀρχαί in pairs, as air and fire (probably alluding to certain medici), or earth and water (Xenophanes); (3) those who posited four, fire, earth, soul (air), and rain (water), of whom Empedocles was chief (doubtless alluding to the medici of the Sicilian school): all these *res molles* (yielding) *rarasque* (porous) *relinquunt* (I, 743). The porosity of matter is a necessary correlate to its corpuscular constitution.

⁴ I, 271 f. With this passage compare Hipp. II. φυσέων, 3 (6, 94 L.).

by water. He next cites the instances of the invisible effluvia of odoriferous things¹ striking the sense; of heat, cold,² and sound,³ all of which operate by invisible bodies; of the imperceptible evaporation⁴ by which garments at the seaside become moist or dry; of the gradual wearing away of a ring⁵ worn on the finger, of stones by the constant dropping of water,⁶ of a ploughshare or pavement in use, and of statues in public places exposed to the touch of passing crowds;⁷ of the infinitesimal increments and decrements of organic growth or decay⁸ which become visible only by summation; of the secular process of disintegration in cliffs overhanging the sea.⁹ This is a formidable list, but it receives additions from other passages, as 6, 921 f., where the poet summarizes the arguments for the existence of effluvia streaming unceasingly from all bodies.¹⁰ Here, besides instances already cited,¹¹ he

¹ 1, 298; cf. 4, 673-686 and 6, 924. For the sense of smell, cf. Epicurus, apud Diog. L. 10, 53. The explanation of the hounds following the scent (4, 680 f.) is found in Empedocles, fr. 102; cf. Beare, *Gr. Theories of Elementary Cognition*, p. 135, n. 2. For the ἀποφοῶν on which the theory rests, see Diels, Anonym. Londin. 33, 15 f. In Anaxagoras, Democritus, and Diogenes of Apollonia, smell depends on such ἀπορροαί. In Heraclitus it is the result of ἀναθυμίασις, his typical form of ἀπορροαί (fr. 7 and 98). Hipp. II. σαρκῶν, 16 (8, 604 L.), like all the older philosophers, connects smelling with respiration.

² 1, 300; cf. 1, 490, 534, 6, 925.

³ 1, 301; cf. 1, 354 f., 4, 524 f., and Epicurus, apud Diog. L. 10, 53.

⁴ 1, 305; cf. 6, 470 f., 616 f.; Diels, Anonym. Londin. 30, 40 f.

⁵ 1, 312; cf. Melissus, fr. 8: ἀλλ' ὃ τε σίδηρος σκληρὸς ἐὼν (sc. δοκεῖ ἡμῶν) τῷ δακτύλῳ κατατρίβεσθαι ὁμοῦ ῥέων (ὁμοῦρέων? Bergk), καὶ χρυσὸς καὶ λίθος καὶ ἄλλο ὃ τι ἰσχυρὸν δοκεῖ εἶναι πᾶν, ἐξ ὕδατος τε γῆ καὶ λίθος γίνεσθαι· ὥστε συμβαίνει μήτε ὁρᾶν μήτε τὰ δντα γινώσκειν. The meaning is clear and is much the same whether we accept the MS. reading or Bergk's conjecture, which is approved by Burnet, *Early Gr. Philosophy*², p. 373, n. 1. But ὁμοῦ ῥέων more clearly marks the connection with the πάντα ῥεῖ of Heraclitus.

⁶ 1, 313; doubtless, as with us, proverbial. See Otto, *Sprüchwörter*, p. 156.

⁷ 1, 313-318. Something of this sort is implied by Melissus, above n. 5. See Otto, *ibid.*, p. 27.

⁸ 1, 322-325; this is the problem of αὔξις and φθίσις to be considered hereafter in connection with nutrition (τροφή).

⁹ 1, 326; cf. 6, 925 f.

¹⁰ It is to be noted that the examples illustrate the view that sense-perception is caused by effluvia, each of the 'five senses' receiving attention in turn. More of this below.

¹¹ That is, odors (6, 924), heat and cold, regarded as pertaining to the sense of touch (925), and sounds (927).

refers to the 'idols' upon which sight depends,¹ and the experience of having a salt taste in the mouth by the seaside or a bitter taste as one watches the preparation of wormwood.² We must not overlook the extensive use which Lucretius makes of the effluvia streaming from all things. It is true that he regards them as atoms, but the conceptions were in no way dependent on this specific interpretation of the phenomena. It would be a long story to enumerate the passages, and we shall content ourselves with a few of the most important. Thus the elaborate system of 'idols' is only a single specialized form of the general doctrine. Evaporation plays a prominent part in the cosmology,³ and in the discussion of meteorological phenomena⁴ it is supremely important. It explains the fact that the sea does not overstep its bounds;⁵ and, besides having intimate relations to the problem of the soul, is invoked to elucidate the striking phenomena of the Plutonia and Lake Avernus,⁶ and of pestilences.⁷ The mystery of the magnet is explained by its effluvia.⁸

After justifying the assumption of infinitesimal corpuscles, Lucretius proceeds⁹ to prove the existence of a void. Here again, as we should expect from the intimate connection of the two conceptions, the facts adduced are in great part the same¹⁰ which we have already met in the arguments for the *corpora caeca*: only we have to note that, in conformity with the new point of view, a new aspect is emphasized. Among

¹ 6, 921-923; see Bk. 4, *passim*, especially 42-109. Special regard is there had to color (74 f.), odor, smoke, and heat (90), and the reflected images in mirrors (98).

² 6, 929.

³ 5, 449-494. It is perhaps worth noting that Bästlein, *Quid Lucretius debuerit Empedocli Agrigentino*, p. 15 f. considers the whole passage an imitation of Empedocles.

⁴ 6, 451-534; 451-507 deal with *ἀναθυμίασις*, 507-526 with precipitation.

⁵ 6, 608-638; cf. 5, 264 f.

⁶ 6, 738-839.

⁷ 6, 1090-1286.

⁸ 6, 909-1089. The magnet is said by Aristotle to have interested Thales, who is reported to have attributed a soul to it (Arist. *de Anima*, 405^a 19). Whether this implies that Thales accepted the view of the soul as *ἀναθυμίασις* or not, we do not know. Aristotle puts it into relation with the power of the soul to move the body; but we do not know his reasons for doing so.

⁹ 1, 329-417; cf. 6, 936 f.

¹⁰ Thus, sounds (1, 354, 489; 6, 951), heat and cold (1, 355, 494, 534; 6, 948), odors (6, 952).

the phenomena not previously mentioned we may cite the following: waters percolating through rocks and dripping in caves,¹ the distribution of foods throughout the body,² perspiration,³ and probably the 'cosmic breathing.'⁴

In a study of Greek corpuscular theories which purported to be exhaustive it would be necessary to make the list of phenomena adduced in support of them complete and to examine each in turn, tracing the history of the conceptions which the Greeks formed of them. A philosophical commentary on Lucretius written by a scholar conversant with Greek philosophical thought and alive to the significance of the arguments marshalled by the poet, is something greatly to be desired, but not soon to be expected. The scattered notes given above merely indicate a few points to be considered. Yet, rightly pondered, they must impress the student with the significance of two facts: first, that the list of important *loci*, or philosophical problems, which were destined to challenge every philosopher, was practically complete long before the formulation of the *atomic* theory; and secondly, that the conceptions with which the several philosophers operated in essaying to solve these problems were actually few in number and derived in the last resort from very simple notions connected with natural phenomena conceived after the manner of primitive man. The significance of some of these conceptions for Greek thought appears to have been generally overlooked. In the remainder of this study a number of these shall be considered somewhat more at length.

¹ 1, 348; cf. 6, 942.

² 1, 350; cf. 6, 946.

³ 6, 944. In connection with sweat Lucretius mentions also the nutrition of beard and hairs over the surface of the body as evidence of its porous nature, apparently not distinguishing between the hair-follicles and the sweat-glands. There is nothing strange in this, as Merrill thinks; the respiratory and vascular ducts or 'pores' are so intimately connected that they constitute one system, and the hairs grow out of the 'pores' of the skin.

⁴ 6, 954: *denique qua circum caeli lorica coerces*. The passage is manifestly fragmentary; but there is no way to reconstruct the text, since the following lines likewise are either incomplete or in confusion. That Lucretius employed the conception of cosmic *ἀναπνοή* or *τροφή* in other connections is certain: thus 6, 483-494, he refers to the entrance of extra-cosmic atoms within the walls of the world, where they unite with the evaporation from the earth and form clouds. We shall presently refer to 1, 988 f., 1037 f., and 2, 1105 f. See p. 140, n. 1.

Probably no other natural phenomenon played so important a rôle in Greek philosophy as evaporation. The generally dry air and strong sunlight of Greece cause evaporation in a measure which must inevitably arrest the attention of an observing people. It may, however, be truthfully said that the significance of the conception for Greek thought has received scant recognition.¹ The failure duly to appreciate its importance can hardly be explained except on the assumption that scholars have tacitly attributed its undoubted prominence in later literature to the influence of the Stoics.

It is true that the Stoics found *ἀναθυμίασις* everywhere in their interpretation of Homer and Hesiod; but the inevitable reaction against their 'allegorical' interpretation should not be allowed to blind us to the obvious facts of history. They did not invent either the term² or the method of interpretation.³ The suggestion of Aristotle touching the true meaning of Oceanus in Homer is well known;⁴ and we are not reduced to the late Allegorist Heraclitus⁵ for testimony that Thales was prompted by considerations connected with evaporation and precipitation to propose the theory that all things are derived from water, since Theophrastus, evidently expanding a hint of Aristotle, briefly advanced

¹ I spoke briefly of this in my paper, *Qualitative Change in Pre-Socratic Philosophy*, *Archiv f. Gesch. der Philos.* XIX (1906), p. 339 f. Burnet, *Early Gr. Philosophy*, ed. 2 (1908), subsequently more fully appreciated its significance, especially in dealing with Heraclitus. Otto Gilbert, *Die Meteorologischen Theorien des gr. Altertums* (Leipsic, 1907), p. 439 ff. has done the subject fuller justice, for which he may have been prepared in part by the studies preparatory to his *Gr. Götterlehre*, 1898, as well as by the detailed study of meteorological phenomena as interpreted by the Greeks. In the field of Greek religion the subject has to my knowledge received no special attention, although it is mentioned incidentally by Gruppe in many connections.

² Diels, *Herakleitos von Ephesos*², p. xvi, regards the word *ἀναθυμίασις* as a coinage of Heraclitus.

³ It is evident that *ἀναθυμίασις* is implied in the interpretation of the *θεομαχία* by Theagenes (6th century), Diels, *Vorsokr.*², p. 511, 16 f.

⁴ Arist. *Meteor.* 347^a 6 f. Cf. Gilbert, *Meteorol. Theorien*, p. 393 f. esp. *ibid.*, n. 2.

⁵ Ritter-Preller, 12^a: ἡ γὰρ ὑγρὰ φύσις εὐμαρῶς εἰς ἕκαστα μεταπλαττομένη πρὸς τὸ ποικίλον εἴωθε μορφοῦσθαι· τὸ τε γὰρ ἐξατμίζμενον αὐτῆς ἀερούται, καὶ τὸ λεπτότατον ἀπὸ ἀέρος αἰθὴρ ἀνάπτεται, συνιζάνον τε τὸ ὕδωρ καὶ μεταβαλλόμενον εἰς Ἰὸν ἀπογαιῶνται· διὸ δὴ τῆς τετραδὸς τῶν στοιχείων ὥσπερ αἰτιώτατον Θαλῆς ἀπεφάνηατο τὸ ὕδωρ. See also Burnet, *Early Gr. Philosophy*², pp. 48–50.

the same view.¹ But it is neither necessary nor profitable to repeat here what has for our present purposes been sufficiently said by others² in regard to the use of evaporation as a cosmic process among the early philosophers.

Before considering the significance of evaporation (*ἀναθυμίασις*) to Greek thought outside the sphere of philosophy proper, it is well to note the scope of the conception. Whatever its etymology and original use,³ it came in time to comprehend all forms of exhalations and emanations.⁴ We may therefore group together under this head phenomena which may not have been called by this particular name in the early period, since our object is merely to indicate the importance of the class of processes in question, which embraces every variety of effluvia (*ἀπορροαί* and *ἀποφοραί*).⁵

¹ See my *Qualitative Change*, p. 340, n. 17, and add Hippolytus cited in Ritter-Preller, 12^a.

² See, e. g., Gilbert, *op. cit.*, p. 445, n. 1, for Anaximander, Anaximenes, and Parmenides; *ibid.*, p. 446, n. 1, for Xenophanes; p. 448 f., for Heraclitus; p. 458, n. 2, for Empedocles and Anaxagoras; p. 459, for Plato. Gilbert recognizes the 'mechanical' character of Plato's explanation of meteorological phenomena, because there is indeed no possibility of interpreting it otherwise; but he believes that the so-called 'monists' regarded the cosmic process as 'dynamic', although the identical conceptions recur in each case. This fact illustrates the pressing need of a study of individual problems and the reconstruction of the history of Greek thought on the basis of such investigations. Thus a critical review of the cosmic *πόλεμος* and of *ἀντιπερίστασις* and *ἀντιμετάστασις*, together with *ἐπικράτεια* and other conceptions derived from the analogy of war, and a similar consideration of the One and the Many in early Greek thought, would contribute more to a clear understanding of questions than the application of metaphysical notions derived from Aristotle or Hegel.

³ Gilbert, *op. cit.*, p. 450, n. 1.

⁴ Cf. *Schol. in Aeschyl. Septem*, 494 (Dindorf, Oxford, 1851, III, p. 355, 7): *λγινόν] ἀναθυμιασιν Ο. καπνόν. καπνός ἀπὸ ξύλων, ἀτμός ἀπὸ ὕδατος, αἰθάλη ἀπὸ λίθου, βδέλος ἀπὸ λύχρου, λγινός ἀπὸ κηρίων καὶ ἐλαίων, κνίσσα ἀπὸ τῶν κρεῶν. Β.*

⁵ Various examples have already been given above. In order to appreciate this class of phenomena one must call to mind that the early philosophers found their *ἀρχαί* in water, 'air', or fire, or in doubtful intermediaries. Where, as in Xenophanes, earth is called an *ἀρχή*, the same fundamental fact of exhalations from the earth returning in precipitation was evidently uppermost in the thinker's mind. Of water and its evaporation we have already spoken. 'Air' in the early time was just vapor or *ἀναθυμίασις*: hence Heraclitus could dispense with it as a substantive form of matter possessing its proper *μέτρα*, and regard it as the mediating factor *par excellence* (cf. fr. 31, δι' αἶρος τρέπεται). In fact *ἀναθυμίασις* in its various stages is the

The apperceptions of primitive man, which gave rise to the scientific concepts of a later age, were not essentially influenced by later developments. Intellectual progress, as it is called, consists generally in combining and rationalizing these early apperceptions; but while the thinker may for a time ignore them, just because they are the presuppositions of his thought, they will ultimately force themselves upon his attention. When he returns to the facts from which his apperceptions were derived, they are no longer data, as they were in the beginning, but they present themselves as problems to be solved by his scientific hypotheses. The task is then comparatively easy; he has only to invert his instrument, so to speak, and look through the other end. The inductive movement gives place to the deductive: out of the hypothesis which he has by induction constructed on the basis of the data, he derives the infallible answer to the problems constituted by the 'facts.' The brief sketch of primitive apperceptions, to which we must now turn, when compared with the proofs of the corpuscular theory and the phenomena explained by the application of the atomic philosophy in the poem of Lucretius, furnishes a good illustration of this dialectic cycle.

The primitive Greek saw in nature the play of daemonic beings: the religion of the people, however much glossed over by the Homeric and post-Homeric tradition, was at bottom one of magic and of occult powers. Spirits were everywhere, and spirits were believed to be chiefly of chthonic origin. The evidence, which is to be found in the handbooks, need not here be repeated. Every one is acquainted with such facts as that mephitic vapors were the objects of worship;¹ that

λεπτομερές, upon which early thinkers relied for their corpuscular theories. Therefore 'air' is prominent in the earlier age until, with the discovery by Anaxagoras that what we call air was not a void, *ἀήρ* came more and more to be used for atmospheric air. Then (perhaps first among the medici) *πνεῦμα* began to assume an important rôle, which it retained under various interpretations until the latest times. The problem of respiration (*ἀναπνοή*), cosmic and microcosmic, doubtless contributed much to its pre-eminence. Alongside *πνεῦμα* the Heraclitic (?) *ἀναθυμίασις* maintained its position largely through the influence of Aristotle and the Stoics. The name *ἀπορροαί*, used by Empedocles, was subsequently more or less superseded by *ἀποφοραί*, which becomes the generic term with Asclepiades, possibly under the influence of Strato. See Sext. Empir., *Math.* 3, 5, Diels, Anonym. Londin., *passim*, and Hero, *Pneumat. Prooem.*

¹ See Frazer, *Adonis, Attis and Osiris*, p. 113 f. See above, p. 120, n. 6.

Plutonia, Charonia, or hell-gates, where vapors or hot-springs issued from the earth, were sacred,¹ because the exhalations were regarded as spirits, — spirits of the dead. It was to these spirits that women looked for fertility,² and mankind for increase of flocks and herds and for the fruitfulness of the soil.³ From Hades, we are told, or from the dead, come not only the souls of the living, but also life, nourishment, growth, and the seeds of fruitfulness.⁴ The spirits of the winds are earth-born, and lord it over the surface of the earth.⁵ It is to the occult influences which they exercise that tabooed objects owe their sacredness.⁶ The Pythia derived her inspiration partly from the aroma of the laurel, chewed and burned, and partly to the vapors issuing from the fissure above which her tripod was placed.⁷ Smoke and aromatics were quite generally regarded as producing 'enthusiasm' or possession by the god-head.⁸ Aromatics, which possess the power of throwing off continuous streams of effluvia without perceptible diminution, had great significance to Greek thought, although it has been generally overlooked. The Fountain of Youth in Ethiopia, described by Herodotus,⁹ was, like the

¹ Rohde, *Psyche*, I, p. 213, n. 1. Cf. Preller-Robert, *Gr. Mythol.* I, p. 811 f., I, p. 283–286. See above, p. 120, n. 6.

² See Rohde, *Psyche*, I, p. 246 f.

³ See Dieterich, *Mutter Erde*, *passim*.

⁴ Hipp. Π. διαίτης, 4 (Π. έννυλιν), 92 (6, 658 L.): τοὺς δὲ ἀποθανόντας ὀρήν (i.e., in dreams) καθαρὸς έν ἱματίοισι λευκοῖσιν ἀγαθόν, καὶ λαμβάνειν τι παρ' αὐτῶν καθαρὸν ἀγαθόν· ὑγίην γὰρ σημαίνει καὶ τῶν σωμάτων καὶ τῶν ἐσιόντων· ἀπὸ γὰρ τῶν ἀποθανόντων αἱ τροφαὶ καὶ αὐξήσεις καὶ σπέρματα γίνονται· ταῦτα δὲ καθαρὰ ἐστέρειν ἐς τὸ σῶμα ὑγίην σημαίνει. Schol. B L II. O, 188: ὁ "Αἰδης οὐ μόνον τὰς ψυχὰς συνέχει, ἀλλὰ καὶ τοῖς καρποῖς αἰτιῶς ἐστὶν ἀναπνοῆς καὶ ἀναδόσεως καὶ αὐξήσεως. Even if καρποῖς bc sound, the statement applies to ζῆα as well as to φυτά; for, while ἀναπνοή (respiration) and ἀνάδοσις (here apparently not *growth*, but distribution or assimilation of food), as well as αὐξήσις, may properly be predicated of plants according to Greek ideas, yet the terms, taken by themselves and in conjunction with the citation from Hippocrates, suggest animals as well. See also Rohde, *Psyche*, I, p. 208, n. 4.

⁵ Rohde, *Psyche*, I, 247 f. See p. 118, n. 4.

⁶ Cf. Farnell, *Cults of the Gr. States*, III, p. 132.

⁷ See Bethe, *Die Dorische Knabenliebe*, *Rh. M.* LXII, pp. 438–475. The doubts recently cast upon the ancient testimony regarding the fissure and the vapors at Delphi are far from convincing to one who has seen the remains of the temple.

⁸ Rohde, *Psyche*, II, p. 60 f.

⁹ Herod. 3, 23. Cf. the vapor-bath (πυρήν) of the Scythians, Herod. 4, 75.

incense, the pleasant savor, and the ambrosia on which the gods fed,¹ aromatic and so ethereal as to be almost comparable to a vapor-bath; the foods partaken at the wedding-feast and at the sacramental meal of the Mysteries are all pungent or aromatic, as are also the herbs laid beneath the dead at funerals.

But it is a bad rule that does not work both ways. The same exhalations which are welcome to one being will prove to be unwelcome to another. What is one daemon's poison is another's meat. Thus exhalations or effluvia of various kinds are the chief apotropaic and purificatory means employed in the most diverse circumstances. It is curious that Gruppe² has failed to note the significance of the mass of material he has gathered. We observed above that to the Greek philosophers from Empedocles onward, and probably from the beginning, perception by all the 'five' senses was mediated by effluvia: sight by the streams of particles emitted from the surfaces of things, hearing and smell by other emanations. Taste was not sharply distinguished from smell, both going for a while by the same name,³ since they are not easily dissociated unless one close the nostrils. Touch included, and probably originally designated chiefly, the temperature sense, which is affected by heat and cold. Both heat and cold were regarded by early Greek thought, and even later in the popular mind, as effluvia.⁴ Indeed, fire was distinctly the typical instance of emanation (*ἀναθυμίασις*), insomuch that Theophrastus could object to the general theory of effluvia that fire was the only element which gave them off. Now it is hardly a mere coincidence that the various apotropaic and purificatory means employed to rid oneself of the malign influence of the daemons fall naturally into classes which emphasize the marked emanations peculiarly adapted to

¹ Cf. Democritus, fr. 25: ἀμβροσίαν δὲ τὰς ἀτμίδας αἷς ὁ ἥλιος τρέφεται, καθάπερ δοξάζει καὶ Δημόκριτος.

² *Gr. Mythologie u. Religionsgeschichte*, II, p. 886 f.

³ That is, ἡδονή. Cf. Arist., *De Sensu*, 4 *init.*, and Heraclitus, fr. 67, Anaxagoras, fr. 4, Diogenes of Apollonia, fr. 4.

⁴ The 'penetrating' power of heat and cold was especially prominent in the thought of the Greeks; hence, particularly in the case of heat and fire, their ability to divide and 'atomize' things was often dwelt upon. Since ἀναθυμίασις epitomized the cosmic process, the action of the heat of the sun or of the outer circle of fire upon the more compact inner circles was viewed chiefly as rendering them λεπτομερής. See above, p. 119, nn. 2 and 11, p. 120, nn. 1 and 10.

the senses. Of course every sensible object must somehow fall upon the senses; but that is no objection to the point here taken. Sunlight, as the power of a superior god, is itself purifying;¹ fire again is the purifying and apotropaic agency *par excellence*, as possessing the most evident and most various emanations. Loud noises and the means, chiefly metallic, of producing them, are considered especially effective; but hardly less the effluvia which strike the sense of smell. 'The daemons love not the reek of torches.'² The purificatory use of sulphur is known to Homer.³ During the great plague at Athens they burned 'sweet-smelling wood.'⁴ Almost all cathartic simples known to the materia medica of the Greeks possess a strong odor, rank or aromatic; wines are diuretic, diachoretic, or constipating according as they are aromatic or not;⁵ flatulent (πνευματώδης) food was tabooed by the Pythagoreans and Empedocles.⁶ The efficacy of olive oil as a daily unguent and at burial was no doubt partly due to its aromatic properties: hence also the use of it, or of wine, in the first bath given to the infant, and subsequently in Christian baptism. Nor should we overlook the extensive use of fumigations by Greek physicians; such as

¹ I cannot recall a passage which clearly and expressly states this fact, but it seems to me obvious from a number of considerations. First, the part of the temple in which the cult-statue was placed was often open to the sun, and to be under a roof with an unexpiated criminal brought on community of taint; corpses were to be hid from the light of the sun, to avoid defiling it—presumably as a source of purity. It was to Delphi that Orestes and other mythical personages went to be purified by Apollo, god of the sun. See Fairbanks, *Greek Religion*, p. 236. The Lacedaemonians killed no one by day, Herod. 4, 146. Parmenides, fr. 10 spoke of καθαρὰς εὐαγέος ἡμελίου | λαμπάδος, on which see Diels, *Parmenides Lehrgedicht*, p. 103 and other passages cited there. Again, in the medical writers the advantages to a site of exposure to the sun are often noted, although it was of course known that in certain cases too much exposure to the sun might prove harmful to a man. Cf. εὐήλιος, and Varro, *R. R.* 1, 12, 3, Sen. *N. Q.* 3, 19, 2, and the Italian maxim, 'Dove non va il sole, ivi va il medico.'

² Plato, *Phaon*, apud Athen. 10, 58, 442 A.

³ *Od.* 22, 481, *Il.* 16, 228.

⁴ Acron, fr. 3 (Wellmann, *Fr. d. gr. Ärzte*, I, p. 109).

⁵ See Hipp. II. *διατρης*, *passim*. Cf. *Kuhn's Zeitschr.* XIII (1864), p. 122 f. Beans and laurel were cathartic, cf. Rohde, *Psyche*, II, p. 181, 2.

⁶ Cf. Iambl. *V. P.*, 106. Pythagoras also forbade the use of wine, *ibid.*, 107. Cf. Wellmann, *Fr. d. gr. Ärzte*, I, p. 30 f. note, and Hipp. II. *διατρη* 2, 45 (6, 542 L.).

the internal fumigation of women after childbirth¹ and as an emmenagogue.² Finally, water, a universal means of purification, doubtless owed its power in part to the abundant evaporation, which connected it on the one side with the fructifying spirits³ which give fertility, and on the other side with apotropaic functions.⁴

The connection of the soul with the system of effluvia has already been touched upon. Indeed, when one has shown that the spirits of the dead were viewed as vapors, one has said all that is necessary. But it may be well to emphasize this point because of the light which it throws on the general question. Rohde's careful and illuminating study has abundantly shown that to the Greeks the soul (*ψυχή*) was a vapor (*πνεῦμα* or *ἀναθυμίασις*). With the breath it enters and with the breath it departs. Like the exhalations of the Plutonia, it tends upwards. In the Sicilian school of medicine we meet with the doctrine that the body is of the earth, earthy, and therefore heavy and inert: the soul, akin to the active fire, levitates the clod and gives it motion and life.⁵ But as evaporation tends upwards, so it is again precipitated; and exactly parallel to the 'way up and down' which sums up the physical cycle of birth and death, the Orphic cycle of necessity in Plato's *Republic*⁶ pictures the souls as ascending and descending. There were many, of course, who held that the soul did not enter the body at birth, but that the embryo became animate at various stages of its development. They had in consequence to provide for breath or vapor in the womb, which was easily done, since the respiratory and the vascular systems were thought to be intimately connected and since the latter were by many held in part to contain *πνεῦμα*. In any case there was never any serious question of the connection of the soul with vapor or breath. Hence,

¹ This was practised until far into the 18th century.

² Diels, *Anonym.* Londin. 37, 30 f.

³ Compare the bridal bath and the bath with fragrant wine to cure sterility. With this should be compared the sprinkling of water as a rain-charm, probably on the principle of sympathetic magic that the resulting *ἀναθυμίασις* would result in a corresponding precipitation.

⁴ Gruppe, *op. cit.*, II, p. 888 f.

⁵ See Diocles., fr. 17 (Wellmann, *op. cit.*, I, p. 124). With this compare the function of fire in Empedocles, fr. 62, 6.

⁶ In the vision of Er, son of Armenius, 614 B f.

as in the story related of Democritus,¹ the soul or life might be artificially maintained by inhaling the vapors of steaming loaves fresh from the oven or by similar devices. Asclepiades, we are told, interpreted this supposed fact as a stimulation or rousing of the soul,² probably regarding it as similar to the case of awakening, in which the soul, reduced to a low ebb in sleep, is reinforced by the accession of breath (*πνεῦμα*) from without. According to Heraclitus,³ apparently, the soul in Hades directly receives the vapors into itself and whiffs odors, very much as the wraith-like Epicurean gods are maintained by the accession of atoms. As the Atomists⁴ found in the motes visible in sunbeams analogues of their atoms, the Pythagoreans saw in them either souls or that which moved the soul.⁵

We see, then, that the Greeks identified roughly soul and vapor. Identification in the strict sense is not the work of practical but of theoretical intelligence. When one formulates the thoughts of everyday life the result is a judgment, in which the subject is particular and the predicate general. It thus registers the direction of interest, since it indicates at once the matter which engages the attention and the universal to which it is referred in the naïve belief that the act of reference is an explanation. Identical or convertible propositions, in which either term may be subject and either term predicate, would seem to arise as the result of the conjunction of two distinct movements of thought; or, to state it otherwise, strict identification of terms is possible only to reflection when, assuming the attitude of the critic, it

¹ Diels, Anonym. Londin. 37, 34 f.

² *Ibid.*, 37, 54 f.

³ Fr. 98. Cf. Plut. *de Fac. in orbe lunae*, 28, p. 943, who quotes the passage. Probably this thought was in part suggested by the ancient practice of setting marjoram and *ἀγκυθοί* of myrrh under the corpse at the *πρόθεσις*, on which see Rohde, *Psyche*, I, p. 219, and Bekker-Göll, *Charikles*, III, p. 124, Dieterich, *Nekyia*, p. 74, n. 5. See also Plut. *de Sera num. vind.*, 22 in the Aridaeus-Thespesius myth, where the souls feast on odors. An interesting illustration occurs in II *Cor.* 2, 16, with which cf. *Eph.* 5, 2. Reitzenstein, *Hellenistische Mysterienreligionen*, p. 52, has not seen the full force of this. God, as *πνεῦμα*, smells sweet savors (*Gen.* 8, 21, cf. the Homeric *κλίσση*); and since the true Christian is *πνευματικός*, that which feeds (or pleases) God, will feed him also, whereas to the *φυσικός* it is a pestilential breath from the grave.

⁴ Arist. *de Anima*, 403^b 28 f.

⁵ Arist. *ibid.*, 404^a 16 f. and Themistius, *ad loc.*, 9, 27.

seeks an evaluation of one course of thought or action in terms of another. Returning to the question in hand: the Greek of the animistic stage said 'vapor is soul,' since 'soul' was his universal. When the proposition was stated the other end to: 'soul is vapor,' the terms were not strictly equated. The new judgment expresses the new consciousness which inevitably led to philosophy. And when one notes the extension of the term vapor (*ἀναθυμίασις*) and the facts for which it provided the acceptable predicate, it is clear that philosophy was predestined to assume the form of a corpuscular theory of the world. So far as we can tell, soul and vapor were never absolutely equated; but in the philosophical thought of the Greeks the materialistic (and mechanical) direction registered in the primitive judgment 'soul is vapor' was destined to prevail, even where it proved logically incompatible with the superficial teleology imported in the Socratic period.

We must now turn to the consideration of a number of phenomena which are of a physiological nature. It is not necessary to debate the old question whether cosmological or physiological questions first engaged the attention of Greek philosophers; for we are clearly not yet in a position to arrive at an intelligent answer. Here as everywhere the study of the history of special problems must precede the general statement of results. But there is a question on which one must arrive at some conclusion before discussing the points which are presently to be treated: to wit, What was the relation between philosophy and medicine in Greece? It has been the common view that medicine was wholly dependent on philosophy, wherever there is a clear dependence of one on the other; a view apparently justified by a number of works included in the *Corpus Hippocrateum*. It is true that there is a certain eclecticism to be noted in them and a striving to accommodate the views of the author to those of contemporary or earlier philosophers. Yet this dependence has probably been much overstated by even the most careful investigators. Two points should be well considered. First, our knowledge of Greek medicine in the fifth century is limited. In spite of the volume of 'Hippocratean' writings we know from indications contained in this very literature and from the list of names of other physicians whose works are utterly lost that we possess only a small fragment of the medical literature of the time. So impenetrable is the darkness that there is little hope of a successful issue to the per-

sistent efforts being made to assign the existing works of 'Hippocrates' to the several schools then flourishing, not to speak of the impossibility of deciding which, if any, of the extant works are to be attributed to Hippocrates himself. Then, again, we must bear in mind that the physician was a recognized craftsman even in the Homeric age,¹ and that the medical tradition, mediated by the guilds and priesthoods, must have preserved elements from a period antedating philosophy. 'Hippocrates' speaks of the ancient and honorable art of medicine, and we have every reason so to regard it. Such being the case, it must appear to be a hazardous assumption that where there is an obvious dependence of one upon the other, medicine must always be the borrower. It is surely wiser to suspend judgment, at least for a time, than to take for granted, for example, that Empedocles is to be credited with the origination of all the doctrines in which the Sicilian school agrees with him.² Such caution is the more to be recommended because there are points of doctrine in which Empedocles and Anaxagoras agree not only with one another but also with a clear medical tradition not necessarily dependent on them. And when one notes that these points of agreement relate in part to physiological processes which primarily concern the physician, such as the process of nutrition, one is the more inclined to a prudent *non liquet*; for the exigencies of prescribing medicine or diet must early have compelled the physician to formulate some theory, if indeed he had not such a theory ready to his hand in the common assumptions which he shared with the people at large.

Among the physiological processes to which we desire to draw attention is that of waste and repair. This applies to the cosmos, which the Greeks quite generally regarded as a living organism (*ζῶον*), quite as

¹ *Od.* 17, 383 f. Cf. Plato, *Rep.* 599 C. We should not forget Democedes, the most illustrious representative of the Crotoniate school, who served as court physician to Pisistratus, Polycrates, and Darius. His father belonged to the Cnidian school, and Democedes is said to have written a medical treatise. All indications point to a long development, although the links of the chain are generally missing. See Diels, *Vorsokr.*², p. 32 f.

² So Wellmann, *Fr. der gr. Ärzte*, I, *passim*. See, e. g., p. 35 in regard to embryology and gynecology, where he accepts the conclusions of Friedrich's *Hippokratistische Untersuchungen*, Berlin, 1899.

much as to the microcosm. In both alike continued existence depends on the maintenance of a proper balance between receipt and expenditure. The losses go by the name of ἀπόκρισις or ἔκκρισις, accessions by that of εἰσκρισις. During a part of life the latter are in excess of the former and the organism experiences growth (αὔξησις); when the ratio is inverted it suffers loss (φθίσις). The beginning of growth is origination (γένεσις), the consummation of loss is destruction (φθορά). Since, as we have seen, Greek thought did not conceive of origination as creation *e nihilo*, nor of destruction as annihilation, γένεσις and φθορά are strictly in line with growth and decay and relative to the particular entity which, like all things perfect, for the Greek had beginning, middle, and end. The middle represents the attainment of the meridian of life when the functions, like the sun in his course, seem for a space to stand still in perfect balance (ἰσορροπία).

Both waste and repair are effected partly in the gross; but with this aspect of the functions Greek theory concerned itself but little, since it marks only the beginning and end of the respective processes. Essentially each consists in the addition or removal of minute particles, without which the various operations could not be conceived. We do not know when this fundamental fact first arrested the attention of Greek thinkers: but certain factors of the problem were assuredly a portion of man's earliest thought. That breath, both as inhaled and as exhaled, was material and composed of minute particles; that food, in order to subserve its purpose, must be masticated or comminuted; that there were channels for the reception of breath and of food; and that both found their way somehow into the recesses of the body,—these are observations which did not await the dawn of philosophy or of scientific medicine. Alcmaeon, in the sixth century B.C., used the term 'pores' (πόροι) of the channels of sense,¹ and doubtless of the other ducts of

¹ See Diels, *Vorsokr.*², p. 101, 18 and 29 f. (hearing), *ibid.*, 21 f.: μανόθητα (taste), *ibid.*, 24 f.: ἀπάσας τὰς αἰσθήσεις συνηρτησθαι πῶς πρὸς τὸν ἐγκέφαλον . . . ἐπιλαμβάνειν γὰρ τοὺς πόρους, δι' ὧν αἱ αἰσθήσεις; *ibid.*, 32 f. (goats breathing through the ears, probably to explain hearing); *ibid.*, 34 f. (for smell); *ibid.*, 42 and p. 102, 1 (sight). These πόροι are not empty, p. 101, 44: naturalem spiritum continentes. That Alcmaeon used πόροι also of other ducts is made highly probable by Arist. *de Gen. animal.* 744^a 8 f., and the same conclusion naturally follows from his pronouncements concerning the nutrition of the embryo (*Vorsokr.*², p. 103, 11 f.), which takes in nutriment 'like a sponge,' and concerning sleep and death (*ibid.*, 16 f.).

the body. How much earlier they may have borne this name we do not know; but, although dissection may not have been practised before Alcmaeon, we know that the Greeks had long been accustomed in the slaughter of animals for sacrifice to observe minutely the condition of the inner organs. Under these circumstances it is inconceivable that they should not have studied the anatomy of the victims with a view to throwing light on human physiology, particularly since the early history of the science is marked by inferences—often erroneous—drawn from the analogy of certain animals. We may be sure, therefore, that the principal facts of physiology upon which the theory of waste and repair is based were known to the Greeks not later than the beginning of the sixth century B.C.

This process was known as that of nutrition (*τροφή*). It may at first appear strange that respiration (*ἀναπνοή*) was regarded by the Greeks as a variety of nutrition alongside *τροφή* in the narrower sense. But the fact is well attested,¹ and even if it were not, the close analogy of the two functions as well as the intimate connection of the respiratory and vascular systems, particularly as understood by the Greeks, would force us to this conclusion. Apparently at an early period food proper was roughly divided into 'dry' and 'moist,'² although it was well understood that in order to become a nutrient all food must be liquefied, wherefore water was regarded either as the nutrient *per se* or as the vehicle of nutrition.³ If now we recall that breath, itself a form of

¹ See, e. g., Hipp. II. *τροφῆς*, 30 (9, 108 L.): ἀρχὴ τροφῆς· πνεύματος, ῥίνες, στόμα, βρόγχος, πλεύμων, καὶ ἡ ἄλλη διαπνοή· ἀρχὴ τροφῆς καὶ ὑγρῆς καὶ ξηρῆς, στόμα, στόμαχος, κοιλίη· ἡ δὲ ἀρχαιότερη τροφή, διὰ τοῦ ἐπιγαστρίου, ἥ ὀμφαλός. Clearly breath and blood are the only true *τροφή*, all other nutrients must be first reduced to blood: cf. Galen, *ad loc.*, 15, 388 K.: καὶ διὰ τούτων ὅλον ἐκ πρέμνων τινῶν ἐκ τῆς μήτρας ἔλκει τὸ ἔμβρυον αἷμα καὶ πνεῦμα, ὅπερ Ἰπποκράτης ἀρχαιότεραν καὶ πρωτίστην τροφήν καλεῖ. See above, p. 132, n. 1.

² See Hipp. II. *τροφῆς*, 1 (9, 98 L.) and 30 (quoted in preceding note). Henceforth it became a commonplace.

³ Athen. 2, 18 (43): καὶ ἡμῶν δὲ πᾶσα δύναμις ἐξ ὑδάτων ἀρδεταί. Hipp. II. *τροφῆς*, 55 (9, 120 L.): ὑγρασίη τροφῆς ὄχημα. Blood is the *ὑγρασίη* of the body (see above, n. 1) and is according to Empedocles the real nutrient of animals as water is of plants. Cf. also Aristotle, *de Part. animal.* 651^a 14 f. Moisture, as we have seen, is the nutrient *par excellence* of fire: cf. Hipp. II. *διαίτης*, 1, 3 (6, 472 L.) and Theophr. *de Igne*, 20. These facts are closely connected, because food is changed by the native heat of the organism (by 'cooking,' *πέψις*) into *ἀναθυμᾶσις*,

nutriment, was considered 'cold' as inhaled, and 'hot' as exhaled, we obtain in the classification of the nutrients of the organic body the generic contrarieties postulated, according to ancient authorities,¹ as the primary distinctions arising out of the Apeiron of Anaximander, and henceforth destined to play a foremost part in the philosophy of Greece.²

It is quite natural therefore that vapor should have been spoken of as breath; for the earth and the sea were commonly conceived in the familiar way as breathing,³ now exhaling warm vapors and again receiving back the cooling showers. This is poetry; but poetry has ever been the elder sister of philosophy. Breathing to the Greek was not, however, restricted to respiration (*ἀναπνοή* and *ἐκπνοή*); it included also 'perspiration' (*διαπνοή*). The living creature breathes at every pore.⁴ We know the theory of Empedocles, according to which breath surges out and in at the pores, 'the bloodless tubes of flesh extended over the surface of their bodies,'⁵ successively driving back and yielding before the recurrent blood. The pores are at no time empty,⁶ since each

in which form it passes through the minute ducts of the body, partly as *πνεῦμα*, partly as a saline precipitate (e. g., urine). These or similar views were widely held.

¹ Diels, *Vorsokr.*², pp. 13, 14.

² By Empedocles, or at least by the Sicilian school of physicians, these were regarded as the 'elements' of the body. Cf. Gilbert, *Meteorol. Theorien*, p. 340, n. 1, and Wellmann, *Fr. d. gr. Ärzte*, I, pp. 69-93.

³ Hom. *Od.* 5, 469: *αὔρη δ' ἐκ ποταμοῦ ψυχρὴ πνέει*, with which cf. Herod. 2, 19, and 27. Cic. *N. D.* 2, 10, 27: Ipse enim <aër> oritur ex respiratione aquarum; earum enim quasi uapor quidam aër habendus est. Sen. *N. Q.* 2, 10, 2 f.: *terrenas exhalationes . . . terrarum halitu*. That winds are breath or breathe is a commonplace from Homer onwards; cf. Hipp. II. *φυσέων*, 3 (6, 94 L.). We shall presently meet this conception again in cosmic respiration. The word *αὔρα* has interesting associations; thus Ar. *Av.* 1717 uses it of the fragrance of incense, and Opp. *Hist.* 4, 114, of the subtle influence of a female.

⁴ See above, p. 133, n. 1. Alcmaeon probably held this theory, see p. 132, n. 1. For a fuller statement of *διαπνοή* see Galen 5, 710; 6, 67; 15, 180; 19, 375 K. With it is, of course, connected also the 'sensible (as opposed to 'insensible') perspiration,' called sweat, a notion which Empedocles, fr. 55, likewise applied to the cosmos, calling the sea the 'sweat' of the earth.

⁵ Empedocles, fr. 100, transl. Burnet.

⁶ Again cf. Alcmaeon, above, p. 132, n. 1, and Hipp. II. *φυσέων*, 3 (6, 94 L.), where the water of the sea is said to contain air between its drops, which is breathed by fishes: *κενέον τε οὐδὲν ἔστιν τούτου* (sc. *ἥερος*). Cf. also my *Qualitative Change*, p. 356, n. 67.

adversary in turn presses hard upon the retiring foe. It is worthy of notice that the theory implies no separation between the vascular and the respiratory systems except at the surface, where the pores are of a size to admit of the free flow of air but to prevent the blood from following it. This theory is highly developed, and we cannot trace it earlier than Empedocles,¹ though it afterward found many supporters.² But we need not therefore conclude that Empedocles originated the several views which he perhaps first combined into a well-articulated hypothesis. Against this conclusion several considerations speak with cumulative force. First, the notion of 'perspiration' was evidently much older than Empedocles, at least as applied to the cosmos; and, secondly, the intimate connection of respiration and nutrition, upon which the Empedoclean theory rests, may with equal assurance be claimed as a discovery of an earlier age.

There is a passage in Hippocrates *Περὶ φύσιος παιδίου*³ which deserves to be quoted because of the light it throws on Greek conceptions relative to breathing. Although it relates to the human embryo, the process described is purely physical. After speaking of conception, the writer proceeds: 'The embryo collects and solidifies under the action of heat. Then it acquires breath, partly from being in a warm place, partly because the mother breathes; and when it is filled with breath, the breath makes a passage for itself outward through the middle of the embryo, whereby the breath escapes. Now, when a passage is made

¹ Yet, as we have just seen, there is a strong presumption that Alcmaeon held much the same view.

² See Wellmann, *Fr. d. gr. Ärzte*, I, p. 70 f.

³ C. 12 (7, 486 L.). With this passage cf. II. *ὀκταμήνου*, 12 (7, 456 f. L.). The main duct of the foetus is of course that which connects with the umbilical cord. Ancient medical writers were not agreed whether all *τροφή* (including breath) entered by the cord. Alcmaeon, as we have seen, said that the foetus took in nourishment like a sponge, which implies many openings. II. *ὀκταμήνου*, *loc. cit.*, expressly affirms that all other channels are closed until after birth. II. *τροφῆς*, 30 (9, 108 L.), seems to take much the same view. The case of the chick in the egg in II. *φύσιος παιδίου*, 30 (7, 536 L.), is very similar to that of the human foetus (c. 12), but the shell is supposed to admit sufficient air, and clearly not at any one point. II. *διαίτης*, 1, 9 (6, 482 L.), a distinction is made between periods; at first, when all is rarefied, food enters equally everywhere, but later, as the exterior of the foetus solidifies and condenses, special passages are formed. II. *σαρκῶν*, 6 (8, 592 f. L.), the foetus inhales and sucks in the womb, clearly not by the cord.

outward for the warm breath, cold breath is inhaled in turn from the mother; and this occurs continually. For, being in a warm place, it becomes warm; it derives cold (air) from the mother's breathing; and everything that becomes warm obtains breath.¹ The breath breaks and makes a way for itself and goes out: but that which is warmed of itself again draws cold breath to itself through the passage it has forced, and by it is fed.² This may be observed in wood and leaves, in food and drink, in fact in anything that becomes very warm. Burning wood will furnish a good illustration: for all kinds of wood will do it, most of all that which is somewhat green. It emits breath at the point where it was cut, and the breath when it goes forth circles round the cut: a thing we see continually occurring. The inference in regard to the breath is evident, viz., that when it is warm in the wood it draws in to replace itself³ other air that is cold, by which it is fed, and again expels it. . . . These natural laws are adduced to prove that the embryo inhales and exhales breath. At the same time it gets breath from the mother's respiration; for when she draws cold breath from the air, the embryo partakes of it.⁴ The origin of the membrane which encloses the foetus is next described.⁴ Now it is clear from this account that the physiological process is here, as in Empedocles, conceived in terms of inanimate nature, only strictly mechanical principles being involved. Yet the materials burned in the fire are all organic products and hence possess the pores necessary for the circulation of air, which the author regards as breathing.

Two points are noteworthy in this account of respiration. First, it is obviously due to the expansive and rarefying action of heat, which is checked and compensated by the contracting and condensing power of cold. That upon which the heat of the womb acts is also clearly the moisture in the foetus, which, becoming heated and converted into vapor,

¹ Cf. Arist. *de Respir.* 472 f.

² Note here the use of *τρέφεται* and *τροφή*, as it continually occurs in Hippocrates (e.g., II. *σarkῶν*, *passim*) in speaking of respiration.

³ *ἐπιστῆ*. Here is a case of *ἐλξίς* or *ὀλκή*, but it is purely mechanical, based on the *horror vacui*. When Plato (*Tim.* 80 A. f.) criticises the use of *ἐλξίς*, he is merely objecting to a term which seems to him susceptible of a wrong interpretation. He did not introduce a new conception.

⁴ Cf. Hipp. II. *σarkῶν*, 3 f. (8, 586 f. L.).

forces a passage outward, thus establishing a means of communication with the outer air. There is no mention of many such vents established, but we need not conclude that only one is thus formed: the writer has in view the principle involved, which remains the same whether there are many or one. In the second place, this process involves the notion of an integument which is more or less dense and requires to be opened at certain points to admit of the egress and ingress of air. In the embryo this is provided by the surrounding membrane, just as the cosmos has its firmament.¹

We are therefore prepared to understand the conception of cosmic respiration. The circulation of matter within the universe, analogous to that of the warm breath or the blood in the embryo, we have seen typified by 'the way up and down' of evaporation and precipitation. The analogy of the microcosm, however, inevitably suggested that this process needed to be supplemented by another. Just as the circulation of the vascular system is dependent on respiration (including perspiration through the innumerable cutaneous pores), so the world also must be thought of as breathing. This must have appeared the more necessary because of the fact that the world, regarded as an animate being (*ζῶον*), could hardly be conceived as continuing its existence without being fed. Accordingly we find Anaximenes in the sixth century supplementing his theory of the way up and down in the world with the conception of cosmic respiration. 'As our soul,' he says,² 'being vapor holds us together, so do breath and vapor surround the whole world.' When it is said³ that Xenophanes denied that his cosmos-god breathed, the meaning is clear. He must have held that, since the world was without beginning and end, and perfect, lacking nothing, there was neither need nor place for the breathing of the cosmos, which serves to maintain it, as food and breath repair the losses of the body. That such was indeed

¹ This is conceived as a *ὕμην* in the cosmogony of Leucippus (Diels, *Vorsokr.*², p. 343, 10, 14 f.). With this cf. Hipp. II. *σαρκῶν*, 3 (8, 586 f. L.), and II. *φύσιος παιδίου*, 12 (7, 488 L.). In the former passage read *ταῦτα καταληφθέντα περὶ αὐτὰ (αὐτὰ L.) σηπεδόνας ποίει ολονπερελ* (ολον περὶ vulg.; οἶον περ L.; cf. Plato, *Theæt.* 201 E) *χαιτώνας*.

² Fr. 2.

³ Diog. L., 9, 19: *οὐσίαν θεοῦ σφαιροειδῆ, μηδὲν ὁμοιον ἔχουσαν ἀνθρώπῳ· ὅλον δὲ ὁρᾶν καὶ ὅλον ἀκοῦειν, μὴ μέντοι ἀναπνεῖν*.

the thought of Xenophanes is made doubly sure by a passage in Plato's *Timaeus*¹ which seems not to have been considered in this connection. In all this there is prominent the conception of insensible but cumulatively significant loss to the organism by the constant stream of effluences. In the third century Erasistratus² seems to have constructed the first crude 'respiration-calorimeter' in order to measure the extent of this loss. He took hens and other fowls and placed them in a jar, first feeding and weighing them carefully; after a time he took them out and again weighed them together with the visible excreta. The difference measured the amount of 'insensible perspiration.' Anaxagoras likewise clearly held the doctrine of cosmic respiration, for therein he finds the *Nous*, by which all within the world is ordered. 'The *Nous*,' we read,³ 'which ever is, is certainly there where everything else is, in that which surrounds the cosmos, as well in what has been added⁴ (to the Infinite) as in that which has been separated off from it.' *Nous* is in short like the 'soul,' which enters and leaves the organism with the breath.

¹ 32 C-33 A. Cf. 33 C: ὁμμάτων τε γὰρ ἐπεδεῖτο οὐδέν, ὁρατὸν γὰρ οὐδὲν ἀπελείπετο ἕξωθεν, οὐδ' ἀκοῆς, οὐδὲ γὰρ ἀκουστόν· πνεῦμά τε οὐκ ἦν περιστὸς δεόμενον ἀναπνοῆς, κτλ. Cf. also Aët. 2, 5, 1 (*Dox.* 332 f.): [πόθεν τρέφεται ὁ κόσμος] Ἀριστοτέλης· εἰ τρέφεται ὁ κόσμος, καὶ φθαρήσεται· ἀλλὰ μὴν οὐδεμῶς ἐπιδείχεται τροφῆς· διὰ τοῦτο καὶ αἰδιός. Achilles, p. 128 E (*Dox.* 332 f.): Ἀριστοτέλης δὲ μὴ δεῖσθαι τροφῆς αὐτὸν λέγει, τὸ γὰρ δεόμενον φθαρτόν. ὁ δὲ αἰδιός ἐστι κατ' αὐτόν. The same point of view obtains in the opposite opinion of Epicurus, Aët. 2, 4, 10 (*Dox.* 331): Ἐ. πλείστοις τρόποις τὸν κόσμον φθείρεσθαι, καὶ γὰρ ὡς ζῶν καὶ ὡς φυτὸν καὶ πολλαχῶς.

² Diels, Anonym. Londin. 33, 43: πρὸς δὲ τοῦτοις καὶ Ἐρασίστρατος περᾶται κατασκευάζειν τὸ προτεθέν. εἰ γὰρ λάβοι τις ζῶον οἷον ἔρυνθα ἢ τι τῶν παραπλησίων, καταβοῦτο δὲ τοῦτο ἐν λέβητι ἐπὶ τινὰς χρόνους μὴ δοῦς τροφήν, ἔπειτα σταθμῆσθαι τοὺς σκυβάλοις τοῖς αἰσθητῶς κεκενωμένοις, εὐρήσει παρὰ πολλὸν ἔλασσαν τοῦτο τῷ σταθμῷ τῷ δηλονότι πολλὴν ἀποφορὰν γεγενῆσθαι κατὰ τὸ λόγῳ θεωρητόν.

³ Fr. 14.

⁴ The reading here and below is at first sight strange, though the sense is clear. Adam, *The Religious Teachers of Greece*, p. 257, n. 3, proposed ἀποκριθεῖσι for προσκριθεῖσι and ἀποκρινομένοις for ἀποκεκριμένοις. But Adam probably misconceived the point of view, which seems to be here (as in fr. 4, Simpl., *Phys.* 156, 4: πρὶν δὲ ἀποκριθῆναι κτλ.) that of the πολλὰ περιέχον, in which πάντα ἦν ὁμοῦ. Cf. also ἐπέκκρισιν, Diels, *Vorsokr.*², p. 343, 15, where we, naturally taking the cosmos as our point of view, should expect ἐπέκκρισιν. See below, p. 139, n. 4.

In general conformity with the point of view here sketched are the doctrines of the Atomists and the Pythagoreans. Since the latter cannot be exactly dated, we shall consider the Atomists first. Aristotle says: ¹ 'It is for this reason too that they regard respiration as the function that fixes life's limit.² They think that the surrounding air presses together and expels the atomic bodies, which, because they are themselves never at rest, impart motion to animals; but that relief comes through respiration, because similar particles thereby enter into the body from without. These latter, by restraining the contracting and condensing element, prevent the spherical atoms which are already in animals from being entirely expelled. So long as they can do this, life continues.' With this statement we must take a few others relative to the world. 'A cosmos continues at the acme of its powers until such time as it is no longer able to take on anything from without.'³ Such additions are mentioned also in the brief cosmology ascribed to Leucippus,⁴ and afterwards in

¹ *De Anima*, 404^a 9 f., transl. Hammond.

² διὸ καὶ τοῦ ζῆν ὄρον εἶναι τὴν ἀναπνοήν. Since respiration is a kind of τροφή, it is natural to find the same language used of the latter; cf. *ibid.*, 416^b 13: τροφή· σώζει γὰρ τὴν οὐσίαν, καὶ μέχρι τούτου ἐστὶν ἕως αὐτῆς καὶ τρέφεται. Further instances are cited below, *passim*.

³ Hippol., *Philos.* 1, 13 (*Dox.* 565, 18 f.): ἀκμάζειν δὲ κόσμον, ἕως αὐτῆς μηκέτι δύνηται ἔξωθεν τι προσλαμβάνειν. With this compare August., *C. D.* 8, 2: non enim <Anaximander> ex una re sicut Thales ex umore, sed ex suis propriis principiis (that is, out of *semina certa*!) quasque res nasci putauit. quae rerum principia singularum esse credidit infinita, et innumerabiles mundos gignere et quaecumque in eis oriuntur; eosque mundos modo dissolui modo iterum gigni existimauit, quanta quisque aetate sua manere potuerit, nec ipse aliquid diuinae menti in his rerum operibus tribuens. How much weight one shall attach to this statement will depend on one's point of view. The doctrine of Anaximander as here stated is an exact prototype of that of Anaxagoras, excepting the Nous. But, even if we hold that Augustine confused Anaximander and Anaxagoras, the statement holds true of the latter. I believe also that in most particulars Anaxagoras did simply restate more explicitly the thought of Anaximander. For the ἀκμή cf. Diog. L., 10, 89; Lucr. 2, 1105 f.

⁴ Diels, *Vorsohr.*², p. 342 f. The cosmos originates (as in Anaximander and Anaxagoras) κατὰ ἀποτομήν ἐκ τοῦ Ἀέρος, and a πρῶτον σύστημα arises, which forms as it were a membrane (οἶον ὑμένα, cf. p. 137, n. 1) about itself. This 'membrane' or caul of the world receives additions: *ibid.*, p. 343, 14: αὐτὸν τε πάλιν τὸν περιέχοντα οἶον ὑμένα αὐξεσθαι κατὰ τὴν ἐπέκκρισιν (cf. p. 138, n. 4) τῶν ἔξωθεν σωμάτων· διὸν τε φερόμενον αὐτὸν, ὧν αὐτῶν ἐπιφύσσει, ταῦτα ἐπικτᾶσθαι. This relates to the 'childhood of the world,' when it is growing rapidly; in its decline the loss would be emphasized; see preceding note. Cf. the Atomist account of human respiration, Arist., *de Respir.* 472^a 5-18.

the Epicureans.¹ The opinions attributed by Aristotle to the Pythagoreans must be interpreted in the light of these conceptions. 'There need be no doubt whether the Pythagoreans postulate generation or not; for they obviously say that when the One had been constructed, whether out of planes or of superficies or of seed² or of something they are at a loss to name, straightway the nearest part of the Infinite was drawn in and limited by the Limit.'³ 'The Pythagoreans likewise said that there was a void and that into the outer heaven itself, as if breathing, the void entered with other elements and here delimits substances.'⁴ 'Aristotle states in the first book of his work on the Pythagorean philosophy that the heaven (cosmos) is one and that from the Infinite there are drawn in also time⁵ and breath and the void⁶ which ever delimits the spaces of all things.'⁷

¹ Cf. Diog. L., 10, 73 (growth and decay of a cosmos); 10, 98 (growth of one world at the expense of another). The *locus classicus* is Lucr. 2, 1105 to the end of the book. The same point of view is taken elsewhere, as 1, 998 f., 1037 f. See also 5, 91 f., 235 f. Zeller, *Phil. der Griechen*, III, A.³, p. 409, n. 6 has collected the passages. The connection of all this with τροφή (cibus) is clearly brought out by Lucr. 2, 1133 f. I do not recall a passage where it is spoken of as cosmic breathing, but in view of the recognized connection of ἀναπνοή with τροφή it makes no difference.

² It is evident that different Pythagoreans expressed themselves differently. When Aristotle says 'seed' he is thinking of the πανσπερμία, a conception which he applies indifferently to Atomists and Anaxagoras. It is known that the latter used σπέρματα in this sense (fr. 4); it is altogether likely that Democritus did (cf. Epicurus apud Diog. L., 10, 89). Since the notion of *semina certa* was so prominent in the thought of the Greeks, we may safely credit it also to the Pythagoreans (cf. above, p. 116, n. 3; p. 117, n. 1 and 3; p. 139, n. 3).

³ *Met.* 1091^a 13.

⁴ *Phys.* 213^b 22.

⁵ Just what the Pythagoreans meant by χρόνος is not clear; certainly it was not abstract 'time.' I incline to think that χρόνος in older Greek thought (e.g., Orphics, Pherecydes, etc.) meant the δίνη or that which caused the δίνη. 'Time' was regularly associated by the Greeks with the revolution of the heavens; and, to cite closely parallel conceptions, the Nous of Anaxagoras (which the cosmos inhaled from the Infinite, cf. p. 138, n. 3) had no other function but to start the δίνη, and it is the accession (respiration) of atoms from the Infinite which causes the δίνη also in the Atomic system.

⁶ The κενόν, as the collocation with πνοή suggests, here probably means atmospheric air (cf. Burnet, *Early Gr. Philosophy*², p. 120 f.).

⁷ Arist., fr. 196 Rose.

It would be superfluous, after setting forth these various conceptions of cosmic respiration, to emphasize the implication of a porous world which they involve and sometimes expressly assume. The pores thus postulated do not need to be empty; all that the theory requires is that they shall afford entrance and exit to the streams of breath or vapor created by the action of heat, partly passing out, partly entering to replenish the loss.¹ The elaborate system of pores and effluences presented in the doctrine of Empedocles does not postulate a void; the pores are filled with blood or air. Probably this was the general assumption; except that atmospheric air was loosely spoken of as a void until Empedocles and Anaxagoras proved that it was not.² Consequently we may, without too great improbability, assume that the Pythagorean doctrine reported by Aristotle, whose author we do not know, was older than Empedocles and Anaxagoras. And the theories of Alcmaeon, whose affiliation with the Pythagoreans is well known, countenance us in assigning it to the sixth century.³ The conversion of pores into void interstices between indivisible corpuscles was the work of the Atomists under the spell of Eleatic metaphysics.

The subject of respiration leads naturally to the more comprehensive theme of nutrition (τροφή). We have seen that respiration falls under the head of ἀναθυμίασις, which is the general term for the insensible effluences. But evaporation always implies a certain degree of heat. Hence we find fire or heat playing a prominent rôle in respiration. Generally the excessive native warmth of the body is regarded as creating an expansion⁴ which mechanically draws in the colder atmosphere to check it. Among the Atomists, who held that the soul (breath) was constituted of fiery atoms, the process was simply reversed; inspiration, or the inhaling of soul, imparts warmth and life to the inert frame composed of heavier and less mobile atoms.⁵ Hence, as we should expect

¹ This conception became the foundation of the philosophy of Heraclitus. See my *Qualitative Change*, p. 354. Plato, *Tim.* 43 A, beautifully expresses it: ἐπὶ πρὸντον σῶμα καὶ ἀπὸ πρὸντον . . . ποταμὸν (cf. *ibid.*, 42 A: καὶ τὸ μὲν πρόσλοι, τὸ δ' ἀπλόι τοῦ σώματος αὐτῶν, and Philoponus, *de Anima*, 282, 17 f. Hayduck).

² See Burnet, *Early Gr. Philosophy*², pp. 263, 309.

³ Burnet², *op. cit.*, p. 120 f. on other grounds attributes it to Pythagoras himself.

⁴ See the polemic of Diels, *Anonym. Londin.* 26, 31 f. against Erasistratus, who clearly represented in the main the older conception.

⁵ Cf. p. 128, n. 5.

from the philosophy of Heraclitus, which takes *ἀναθυμίασις* as its keynote and sees in fire the essence of all things, it is in the phenomena of fire as interpreted by the Greeks that we discover the best illustration of the processes of respiration and nutrition. Certain passages have already been cited in the foregoing discussion; but the fullest and best exposition is to be found in Theophrastus *De Igne*. Space will not admit of a further consideration here, although the treatise is in some respects the most satisfactory commentary on early Greek thought.

Several general observations should be made before taking up nutrition in the narrower sense. First we should remember that fire is the active or motive force in the world, and that moisture is *par excellence* the nutritive element: fire is fed by water.¹ But it is water in the form of vapor (*ἀναθυμίασις*) that feeds fire, and in the physiology of nutrition evaporation, under one name or another, played an important rôle. This was probably due to the need of accounting for the infinitesimal increments and decrements of growth and decay. In this connection it is well to recall that, according to another fundamental principle of Greek thought, growth is effected by the addition of like to like, or as it is also stated, a thing is constituted of that by which it is nourished. This would lead to strange conclusions but for another general belief, viz., that water as a nutrient is not, so to speak, chemically pure, but is the vehicle of the specific foods appropriate to individual organisms or organs. In other words, water, as a nutrient, is a mixture of all the ingredients suitable (*οἰκείον*) to the body. It may at first seem strange that the same should have been thought to be true also of the vapors rising from heated water; for we obtain chemically pure water by distillation. But there can be no doubt that such was the belief of the Greeks. If we look for evidence it is to be found in abundance in the medical literature dealing with nutrition; but we can readily understand it when we think of the illustration given by Lucretius² of the salt taste one has when walking by the seaside, or of the miasma that breathes

¹ This is the foundation of *ἀναθυμίασις*; for the sun draws (ἐλκει) or drinks (ἐκπίνει) water or moisture: cf., e. g., Arist. *Met.* 983^b 23 f., Hipp. Π. *διατρῆς*, I, 3 (6, 472 L.); *ibid.* 2, 37 (6, 528), 38 (6, 532 L.); Theophrastus, *de Igne*, 20. See my *Qualitative Change*, p. 340.

² 6, 928 f.

from a swamp.¹ When water evaporates the most volatile (*λεπτομερέστατα*) parts, not necessarily pure water vapor, are carried upwards; the heavier, coarser parts (*παχυμερέστερα*) are separated off and remain behind.² Since growth can take place only by the addition of *corpora caeca*, the former include all true nutrients. The composition of water is generally regarded as due to the absorption of insensible particles taken from the earth or other substances through which it percolates.

The general statement which we have just given of the conceptions underlying Greek theories of nutrition naturally provokes questions which are not readily answered because there does not exist³ a comprehensive account of the matter. The histories of medicine are for such purposes worse than useless, and a first attempt, like that which is here made, cannot hope to be either complete or free from error. Yet every student of Greek thought will recognize the importance of the subject and will be indulgent to the inevitable shortcomings of a preliminary study. First we must distinguish two problems which are closely connected but have not the same history. The general problem of nutrition (*θρέψις* or *τροφή*) and growth (*αὔξησις*) was evidently broached very early and solved on the basis of primitive conceptions: the regulative principles governing the solution never greatly changed, and may be traced in slightly varying phraseology through the entire course of development. In time the detailed process of digestion (generally called *πέψις*) received attention, and the problems raised by it became so interwoven with the earlier one that it is difficult to disentangle them. This fact naturally escaped the later Greeks and consequently they read the later theories of digestion into the early

¹ Cf., e.g., Hipp. Π. διαίτης, 2, 37 (6, 528 L.): τὰ δὲ λιμναῖα καὶ ἐλώδεα ὑγραινὲ καὶ θερμαίνει· θερμαίνει μὲν διότι κοῖλα καὶ περιεχόμενα καὶ οὐ διαπνέεται· ὑγραινὲ δὲ διότι τὰ φυόμενα ἐκ τῆς γῆς ὑγρότερα, οἷσι τρέφονται οἱ ἄνθρωποι, τό τε πνεῦμα ὃ ἀναπνέομεν παχύτερον, διὰ τὸ ὕδωρ ἀπὸ τῆς ἀκίνησις (which causes it to thicken). Rain-water, which they knew chiefly as standing in open depressions, was regarded as peculiarly liable to become putrid and viscous. In the passage just quoted, I incline to set a comma after ἀναπνέομεν, and to read δὲ for διὰ.

² Cf. Diels, Anonym. Londin. 25, 31 f., 32, 39 f. For the *λεπτομερές* in relation to the elements see Arist. *de Caelo*, 3, 5. Fire is there considered as traditionally πάντων τῶν σωμάτων λεπτότατον.

³ At least not to my knowledge. The best statements I have seen are those of Wellmann, but he had evidently not considered the problem as a whole.

conception of growth, thus creating much confusion. It will require prolonged study of all the ancient sources to clear up the questions involved; and this can be effectually accomplished only when the fragments of the several medical writers are edited and arranged in groups according to their respective schools.¹

Let us now return to the problem of nutrition or growth in the most general sense. At the outset we are confronted by a seeming contradiction in the preliminary statement given above. It was said that fire or heat is fed by water or moisture, and that like is fed by like. And yet, according to Greek notions, fire and water are opposites. This contradiction was felt in ancient times, and calls for discussion before we proceed; for, as we shall presently see, it contains in embryo the dispute of later times.² The earliest statement that like is not fed by like, but that nutrition proceeds on the opposite principle, occurs in the only half-serious argument of Plato's *Lysis*,³ where, after playing off against one another the old proverbs 'birds of a feather' and the Hesiodic 'potter to potter is foe and bardling to bardling,' we are told: 'the opposite, they say, is food for the opposite; for like would derive no advantage from the like.'⁴ When we study the context it becomes clear that Plato had only the old cosmological theories in mind; for of the examples of the mutual loves of opposites which he adduced⁵ that

¹ Max Wellmann, in his *Fr. der gr. Ärzte*, I (containing the fragments of Acron, Philistion, and Diocles, of the 'Sicilian school'), has made a notable beginning, the value of which is best known to those who try to work ground which he has not covered.

² This contrast gives occasion for Aristotle's discussion of τροφή, which we consider below. In it he attempts to do justice to both principles, which he reconciles by means of his panacea, ἀλλοίωσις, saying that food in the crude state is 'opposite,' and in the digested form 'assimilated,' to the organism or organ nourished. This is the beginning of the dispute over digestion, which we shall consider later.

³ 215 E.

⁴ I considered this in my *Qualitative Change*, pp. 358 f., 369 f. I neglected there to refer to *Lysis*, 214 E, 215 E, and *Tim.* 57 A. The principle that only dissimilars can interact, which Aristotle attributes to his predecessors pretty generally, seems to have been first stated by Plato. The application of the principle to Xenophanes in [*Arist.*] *de M. X. G.* is clearly unhistorical, being a hybrid begotten of Parmenides, fr. 8, 6 f., and Plato's *Parmenides*, from which the author has derived most of his ideas. Plato, *Lysis*, 214 E, is clearly glancing at Diogenes of Apollonia, fr. 2.

⁵ τὸ μὲν γὰρ ξηρὸν ὕγρῳ ἐπιθυμεῖν, τὸ δὲ ψυχρὸν θερμῷ, τὸ δὲ πικρὸν γλυκέος, τὸ δὲ ὀνὺ ἀμβλέος (!), τὸ δὲ κενὸν πληρώσεως, καὶ τὸ πλήρες δὲ κενώσεως, καὶ τὰλλα οὕτω κατὰ τὸν αὐτὸν λόγον.

of the dry for the moist and that of the cold for the hot alone had any real connection with nutrition (*τροφή*) in Greek thought, the remainder being instances of the popular tables of contrarities.¹ With this statement we must compare that of Aristotle²: 'Since the same faculty of the soul is both nutritive and generative, we must first investigate nutrition; for it is by this function of nutrition that the faculty in question is distinguished from other faculties. *Nutrition is supposed to take place by the law of opposites*, although not every opposite is nourished by every other, but such opposites only as derive both their origin and their growth from each other. Many things are derived from one another, but they are not all quantitative changes, as, e.g., healthy from sickly.³ Nutrition is not applied to these cases in the same sense, *for while water is nutriment for fire, fire does not nourish water. The opposites of food and nourishment appear to apply particularly to simple bodies. There is, however, a difficulty here. For there are some who maintain that like is nourished by like, while others, as we said, affirm the converse of this, viz., that opposites are nourished by opposites, on the ground that like is incapable of being affected by like.*' At first glance this would seem to show that the doctrine of nutrition by opposites was one widely accepted and applied to physiological nutrition; but on a closer view we readily see that Aristotle had no one else in mind but Plato,⁴ and Plato, as we shall presently discover, applied the principle

¹ One is reminded at once of the *συστοιχίαι* of Alcmaeon (R. P. 66) and of the pleasurable changes noted by Heraclitus (see *Qualitative Change*, p. 358 f.). In Plato, *Symp.* 186 A f., the physician Eryximachus refers to Heraclitus in a similar connection.

² *De Anima*, 416^a 18 f., transl. Hammond.

³ This is not derived from Plato's *Lysis*, but it is one of the examples of Heraclitus, fr. 111: *νοῦσος ὑγίειν ἐποίησεν ἡδύ, κακὸν ἀγαθόν, λιμὸς κόρον, κάματος ἀνάπανσι.* Cf. [Arist.] *Eth. Eudem.* 1235^a 17: 'μεταβολὴ πάντων γλυκύ·' ἡ δὲ μεταβολὴ εἰς τοῦναντίον. Burnet, *Aristotle's Ethics*, n. on 1155^b 4 f., refers to *Lysis*, 215 E, as clearly of Heraclitean origin, and queries whether the man from whom Socrates claims to have derived his lore was Cratylus.

⁴ It is well known that Aristotle often says *ἔνοι* or *τινὲς* when he has only Plato in mind; and there are other examples of his taking seriously what was merely said in jest or irony. His own reference to fire and water, and his recognition that the principle holds only for the elements, are proof positive that he was thinking of the *Lysis*. It is even likely that he added 'while water is nutriment for fire, fire does not nourish water' because Plato had said 'the dry desires the moist; the cold, the hot.'

only in the cosmological sense, himself employing the dictum 'like is nourished by like' in the most express terms when speaking of physiological nutrition.¹

We thus find two kinds of τροφή set over against each other. In the strict sense of the term it is applied to the nutrition of organic beings, where the principle 'like to like' holds,² while, as Aristotle himself recognizes,³ the principle of opposites applies only among 'simple' or elemental substances, such as fire and water.⁴ We have, therefore, only to consider whether even in the case of the feeding of fire by water there is an instance of opposite nourished by opposite. And stated so, we perceive that we have to do with the phenomenon of evaporation in which water passes, according to the common opinion of the Greeks, into a tenuous form, leaving its grosser constituents to descend in precipitation and adding itself as fire to fire; for in a true sense it is the fire emitted by the sun returning to its own.

Moisture, as we have seen, is the universal nutrient: remove it from wood, and what otherwise were good fuel decays and will not burn.⁵ Hence the traditional classification of foods as moist and dry⁶ (meat and drink) is conventional only and is not based on an absolute distinction. That which shall serve as nutriment must possess flavor, and flavor or taste is impossible without moisture.⁷ Moisture or water is

¹ *Tim.* 78 E-So E.

² This is emphatically stated by Simpl. *de Anima*, 114, 26 f., Hayduck, and Sophonias, *de Anima*, 61, 27 f., Hayduck.

³ *De Anima*, 416^a 27 f., and Sophonias, *ad loc.*, 61, 25 f., Hayduck.

⁴ The case is quite parallel to that which I noted in *Qualitative Change*, p. 369 f., where Theophrastus failed to distinguish between one set of phenomena in which Anaxagoras recognized interaction and hence upheld the principle of the action of like on like, and another in which Theophrastus scented interaction but Anaxagoras did not. So Plato distinctly lays down the principle that ποιεῖν and πάσχειν take place only between opposites, but does not apply it to τροφή. One must study individual problems and not draw inferences from the principles supposed to be operative in one sphere to another, unless one has evidence that they were seen by the thinker in question to be related. I was in this respect myself at fault at a few points in *Qualitative Change*.

⁵ Cf. Philoponus, *de Anima*, 282, 9 f., Hayduck.

⁶ Hipp. II. τροφῆς, I (9, 98 L.). The classification of nutrients as 'meat and drink' constantly recurs.

⁷ Theophr. *C.P.* 6, I, I.

everywhere the basis of nutriment: only in certain animals does it take on the form of blood, and blood is a mixture of water and earthy substances.¹ Blood and semen also have an admixture of air,² and all blood is warm; hence we may regard blood as a compound of all the elements.³ Stated in this form the conception meets us first, perhaps, in Aristotle; but one who reads Greek philosophical literature will quickly convince himself that the theory is based in all its parts upon the common notions of the people.

That water, as the vehicle of nutriment, was regarded as a mixture is quite evident, and was supported by the observation of springs which have varying tastes. Their waters differ according to the character of the soil through which they percolate.⁴ It was supported also by the observation of differences to be noted in the juices of fruits and the sap of plants. Whence did these variations arise? From the common soil, which must, therefore, contain all kinds of properties. But there were growths so exceptional that not every soil could provide the necessary ingredients;⁵ and even where this was not the case, it was known that wines differed in flavor and excellence not so much from differences of vines as from varieties of soil and exposure.⁶ An organism is modified by what it feeds on. These are all homely observations, which imply no philosophy and are clearly the primitive conceptions of the common man. Occasionally we meet a piece of unmistakable folk-lore, as when

¹ Arist. *de Part. animal.* 668^b 9 f. Cf. Emped., fr. 98.

² Arist. *Meteor.* 389^a 19.

³ Theophr. *de Sensu*, 10 (Diels, *Dox.* 502, 13 f.) finds the reason for Empedocles's identification of mind with the blood in the fact that blood is the most mixed of substances. There is much to be said for this view, but it cannot be further discussed here: it is connected with the large subject of *συμπάθεια*, which I hope to treat at another time. Yet, since like is nourished by like and the blood is the vehicle of nutrients in animals, it must contain all the substances that are to feed the several parts of the body.

⁴ Arist. *de Sensu*, 44^{1b} 1 f.

⁵ Hipp. II. *νόσων*, 4, 34 (7, 546 L.) cites the instance of *σολφιων*, which could not be grown in Ionia or the Peloponnesus, but grew spontaneously in Libya.

⁶ See Empedocles, Aët. 5, 26, 4 (Diels, *Dox.* 439, 14 f.). The text is improved in Diels, *Vorsokr.*², I, p. 164, 19 f. Cf. Hipp. II. *παθῶν*, 60 (6, 268 L.), and Theophr. *C. P.* 4, 10 f.

Pausanias¹ tells of the serpents on Helicon whose virus was made comparatively harmless by the herbs they fed on.

If these considerations provide the means of explaining the variations, we must look elsewhere for the principle of uniformity. The permanence of the species is too obvious a fact to escape even the primitive man: for man does not spring from oak or rock. 'Man begets man,' in Aristotle's stock phrase, is the foundation of all sober thinking; and this thought is not due to philosophy. But the determination of antecedents applies not only to the origination of the individual, but also to his maintenance. One cannot dissociate generation (γένεσις) from nutrition (τροφή), and countless tokens prove that even the primitive Greek did not fail to note the connection. Nutrition serves the ends of growth and repair; but growth and repair alike involve the principle of the accession of like to like. When one grows the organism as a whole retains its identity, but increases in bulk: there is more of the same kind of substance. When waste is repaired it is replaced by its like. Hence we have the organism in its various parts and with its constituent substances to begin with. Later authors speak of this regulative principle as the 'faculty' (δύναμις) of nutrition: Aristotle calls it by preference the 'nutritive soul.' The thought is well expressed in Hippocrates, *Περὶ διαίτης*²: 'Each soul goes its way, possessing more or less organs, requiring neither addition nor subtraction of organs, but demanding more or less room according to the growth or decrease of that which it possesses, and produces the individuals into which it enters and receives what comes to it. But since³

¹ 9, 28. Pausanias there speaks also of the vipers of Phoenicia and Arabia. The former are rendered more venomous by the roots which they eat; the latter, feeding on the perfumes of the balsam-trees, have a mild and less deadly venom. For this bit of folklore, attested by Hom. *Il.* 10, 93 f., see Roscher, *Die Entstehung des Giftkönigs und des Schlangengiftes nach antikem Volksglauben*, *N. Jhrb. für cl. Philol.*, CLI (1895), pp. 329-332.

² 1, 6 f. (6, 478 f. L.). I render the improved text given by Diels, *Herakleitos von Ephesos*², p. 56 f., except where changes are noted. Diels has just published additional critical notes on the text in his *Hippokratische Forschungen* II, in *Hermes*, XLVI (1911), p. 267 f.

³ Diels did not see, what seems obvious, that οὐ γὰρ δύναται does not connect with the preceding, but looks forward to the following, clause; it is an instance of the proleptic use of γὰρ so common in Homer and Herodotus (cf. Kühner-Gerth, *Gr. Grammatik*, § 545, 4). We must replace the period after ἐμμένειν with a comma, and cancel the following γὰρ.

the alien cannot abide in an unfavorable place the unfamiliar¹ goes astray, but those particles which are familiar to one another recognize that with which they settle down: for the congenial settle down with the congenial, but the uncongenial war and fight and separate one from the other. For this reason the soul of a man grows in a man and in nothing else. It is the same with all other large animals: those which part from one another are segregated by violence. I will dismiss the question concerning the other animals and set forth my view touching man. Into man there enters a soul, containing a mixture of fire and water, the constituents of man's body.² It must possess all the constituents that are to enter the body; for if any part were absent in the beginning, it could not grow whether much nutriment entered or little, as it does not have that which is to increase. But if it possesses all the constituents, each grows in its appropriate place when nourishment is added from dry water and moist fire, and forces some constituents (of the food) inwards and others outwards.'

We thus see the nutritive soul in operation effecting a separation of the available constituents of the things taken as food from the unavailable, which are eliminated. We discover also that the principle of selection is the old one of the birds of a feather that flock together and drive off all that are not of their kind. The attraction of like for like is the force at work. 'In all meat and drink³ there is something bilious, aqueous, sanguineous,⁴ and phlegmatic, here more, there less, wherefore things taken as meat and drink differ in wholesomeness. . . . When a man eats or drinks, the body attracts from the abdomen the aforesaid humor, and the vital organs⁵ attract from the abdomen through the

¹ Or, 'unrecognized,' if we read ἀγνωσόμενα, with Θ².

² Here there follows the sentence: ταῦτα δὲ καὶ θήλεα καὶ ἀρσενά [καὶ] πολλὰ καὶ παντοῖα τρέφεται τε καὶ αὐξεται διαίτη τῇ περ ἀνθρώπου. If it is not, as I incline to think, a scholion, the passage is at least misplaced; for it relates to the other animals which the writer proposes to pass over in silence. If it is retained, it should be inserted after either ἐάσω or δηλώσω.

³ Hipp. Π. νοσίων, 4, 33 (7, 544 L.).

⁴ Arist. *Phys.* 188a 2 f.: ἔτι δ' (according to Anaxagoras) ἐν τοῖς ἀπείροις σώμασιν ἐνυπάρχει ἀν ἧδι σὰρξ ἀπειρος καὶ αἷμα καὶ ἐγκέφαλος, κτλ.

⁵ They are here called *πηγαί*; elsewhere, e. g., Π. *φυσέων*, 7 (6, 100 L.), *πηγαί* καὶ *ρίζαι*, or again, e. g., Π. *τροφῆς*, 31 (9, 110 L.), *ρίζώσεις*. These names are interesting in connection with Π. *φυσέων*, 1 (6, 92 L.): *τίς ἀρχὴ καὶ πηγὴ γίνεταί*

veins the humors, each humor attracting its like, and distribute them to the body, just as in the case of plants each humor draws its like from the earth. For the earth contains within itself qualities in countless variety. To all the plants that grow in it, it furnishes its like to each, even as each thing that grows has a humor like unto itself after its kind, and each draws from the earth nourishment like unto itself;¹ for the rose draws from the earth a humor like in quality to itself, and garlic draws from the earth a humor like in quality to itself, and all other plants in like manner. Were it not so, plants would not be like their seeds' (that is, they would not be true to type). These same notions are expressed at length in Hippocrates's *Περὶ φύσιος παιδίου*,² with special application to the human embryo. No doubt it will be said that in these writings the influence of Empedocles is manifest; and this may perhaps be granted, although a certain resemblance at a few points,

τῶν ἐν τῷ σώματι κακῶν; εἰ γὰρ τις εἶδελθὴ τὴν αἰτίην τοῦ νοσήματος, οὗτος τ' ἂν εἴη προσφέρειν τὰ ξυμφέροντα τῷ σώματι, ἐκ τῶν ἐναντίων ἐπιστάμενος [from ἐφίσταμαι, 'bringing up'; cf. II. *φύσιος ἀνθρώπου*, 9 (6, 52 L.)] τὰ βοηθήματα. Here the ἀρχὴ καὶ πηγὴ is the αἰτία. Cf. also Arist. *Meteor.* 353^a 34: οἱ μὲν οὖν ἀρχαῖοι καὶ διατρέβοντες περὶ τὰς θεολογίας (e.g., Hes. *Theog.* 727 f.) ποιοῦσιν αὐτῆς (sc. θαλάττης) πηγὰς, ἔν' αὐτοῖς ὧσιν ἀρχαὶ καὶ ῥίζαι γῆς καὶ θαλάττης. In view of this it is difficult to accept the dictum of Burnet, *Early Gr. Philosophy*², p. 14: 'To Anaximander ἀρχὴ could only have meant "beginning," and it was far more than a beginning that the early cosmologists were looking for: it was the *eternal* ground of all things.' See also my *Περὶ Φύσεως* in *Proceedings Amer. Acad. of Arts and Sciences*, XLV, p. 79, n. 3, and cf. Hipp. II. *τροφῆς*, 24 (9, 106 L.). Empedocles called his elements ῥιζώματα, and, according to Diels, Anonym. *Londin.* 6, 18 f., Hippocrates taught: δίκην τε ἐπέχειν ἡμᾶς φυτῶν· ὥς γὰρ ἐκεῖνα προσερρίζεται τῇ γῇ, οὕτως καὶ αὐτοὶ προσερριζώμεθα πρὸς τὸν ἀέρα κατὰ τε τὰς ῥίνας καὶ κατὰ τὰ ὀθα σώματα. We have no text corresponding exactly to this, but in spirit it accords with II. *φυσέων*. Xenophanes is said to have spoken of the earth as ἐπ' ἀπειρον ἐρριζωμένη, which Empedocles apparently understood as implying that the earth extended downward to infinity. May Xenophanes have alluded to cosmic respiration in this connection? According to a recently discovered statement in the Scholia to St. Basil (cf. Pasquali, *Doxographica aus Basilinusscholien*, in *Götting. Nachr., Philol.-hist. Kl.*, 1910, pp. 201, 203 f.): Παρμενίδης ἐν τῇ στιχοποιᾷ ὑδατοβόζον εἶπεν τὴν γῆν. The scholiast cites this to illustrate the statement that the earth rests on water; but was that necessarily the meaning?

¹ Cf. Hipp. II. *φύσιος ἀνθρώπου*, 6 (6, 44 f. L.), on the action of emetics.

² C. 22 (7, 514 L.); 23 (7, 516 L.); 17 (7, 496 f. L.); cf. II. *σαρκῶν*, 13 (8, 600 L.).

coupled with a degree of independence which is not commonly found in an inferior disciple of a great master, hardly constitutes a proof. In the Iatrosophistae represented in the Corpus Hippocrateum we are confronted with one of the most difficult problems of ancient literature and thought. It is easy to dispose of them as imitators of Heraclitus, as in *Περὶ διαίτης* and *Περὶ τροφῆς*, or of Empedocles, as in *Περὶ φύσιος παιδίου*, *Περὶ φύσεων*, *Περὶ νούσων*, IV, etc.; but if we regard them merely in that light we shall do them injustice and fail to profit by the suggestions they give of the common store of intelligent thought of their time, which was, no doubt, in certain particulars, chiefly in matters pertaining to theory, influenced by the popular systems of philosophy, but nevertheless must have reflected for the most part the general thought of the time. The originality of these writers is not great; but the freedom with which they treat their subjects shows that they did their own thinking. And the very reasons which excuse Plato and Aristotle from taking particular account of them, constitute their best claim to our attention. Aristotle,¹ in taking stock of the philosophical opinions relative to the problems of generation and decay, says: 'Nobody, as I have said, has discussed the principles of growth, except as the first man you meet in the street might express it, that things grow by the accession of like to like; but they do not go farther and explain the method.' He clearly regarded the opinion he so lightly cashiered as a popular notion which merited no further remark.

It would hardly be just to Aristotle's predecessors, however, to conclude that they had not presented a fairly complete view of nutrition. We have seen that each plant was supposed to draw from the earth a humor like unto itself, and that it therefore remained true to its specific type. But this was too general and required to be applied to the several parts of the plant and to the organs of the body. The humor taken in by the organism was not simple, but was a complex composite, containing within itself the constituents appropriate to the particular parts.²

¹ *De Gen. et Corr.*, 315^b 1 f.

² Aët. 5, 27, 1 (Diels, *Dox.* 440): 'Εμπεδοκλῆς τρέφεσθαι μὲν τὰ ζῷα διὰ τὴν ὑπόστασιν τοῦ οἰκείου (so the MSS., 'by the depositing of the appropriate,' which in this case can mean—as indeed τὸ οἰκεῖον always meant in nutrition—only 'the like'; Diels, probably taking ὑπόστασιν in the sense of 'sediment,' unnecessarily changes οἰκεῖον to ὕγρου), αὔξασθαι δὲ διὰ τὴν παρουσίαν τοῦ θερμοῦ, μειῶσθαι δὲ καὶ φθίνειν διὰ τὴν ἐκλείψιν ἐκατέρων.

Nourishment, passing through the vascular system of veins and minor ducts was likened to irrigation;¹ and since the blood is in the higher animals the vehicle of nutriment, it is particularly charged with this function.² It is perhaps significant of the wide currency of this view that when Aristotle³ discusses at length the theory of savor, he states only two theories beside his own. The first is attributed to Empedocles, and supposes 'that water contains in itself the various kinds of savor, already formed, though in amounts so small as to be imperceptible.'⁴ Aristotle does not name the author of the second opinion, but Alexander rightly attributes it to Democritus.⁵ It is stated thus: 'The water must be a sort of matter, qualified, as it were, to produce germs of savor of all kinds, so that all kinds of savor are generated from the water, though different kinds from its different parts.' The third possible view, which is that of Aristotle himself, is then put forward: 'The water is in itself quite undifferentiated in respect of savor, but some agent, such as one might conceive Heat or the Sun to be, is the efficient cause of savor.'

Of Aristotle's own theory we need not speak, since it plainly bears the distinctive character of his favorite conception of a qualitative change (*ἀλλοίωσις*) wrought by some cause in a matter that is opposite or neutral in quality. The theory of Democritus we may dismiss briefly, since it is clearly a metaphysical development of the view attributed to

¹ Hipp. Π. *σαρκῶν*, 13 (8, 600 L.): ἡ δὲ τροφή ἐπειδὴν ἀφίκεται ἐς ἕκαστον, τοιαύτην ἀπέδωκε εἰδὲν ἐκάστου ὁκοῖα περ ἦν (this must mean, 'maintains by what it deposits the character of the several organs such as it was'; but one might have expected *ἰδὲν ἐκάστῳ ὁκοῖον περ ἦν*, 'gave to each organ a nutriment like that of which it was constituted'). ἀρδόμενα γὰρ ὑπὸ τῆς τροφῆς αὖξεται ἕκαστα. Cf. Plat. *Tim.* 78 E, 81 D; Athen. 2, 18 (43): καὶ ἡμῶν δὲ πᾶσα δύναμις ἐξ ὑδάτων ἀρδεται. The peculiar properties of various waters are here illustrated at some length.

² Theophr. *de Sensu*, 24, speaks of τὴν ἐν τοῖς μορίοις τοῦ αἵματος σύγκρασιν as, according to Empedocles, the explanation of the specialization of functions in the organs of the body. Arist. *de Respirat.* 474^b 3: ἡ τροφή μὲν γὰρ ἐξ ἧς ἡδὴ γίνε-ται τὰ μόρια τοῖς ζῴοις, ἡ τοῦ αἵματος φύσις ἐστίν. This doctrine did not originate with him. Cf. Hipp. *Γυναικείων*, 1, 25 (8, 64 L.): κατέρχεται γάρ, ἐπὶ ἡν γαστρὶ ἐχθὴ ἡ γυνή, ἀπὸ παντὸς τοῦ σώματος αἷμα ἐπὶ τὰς μήτρας κατ' ὀλίγον, καὶ περιμυστά-μενον κύκλῳ περὶ τὸ ἐν τῇσι μήτρῃσι ἐὼν αὖξει κείνο.

³ *De Sensu*, 4.

⁴ Cf. Alexander, *ad. loc.* 68, 25 and 67, 19 f.

⁵ The theory cannot be that of Anaxagoras, as Hammond suggested.

Empedocles. Instead of real savors, actually carried in solution in the water, we obviously have the atoms which are qualitatively homogeneous or neutral, but possess the power or capacity¹ to produce qualitative distinctions through combination,² by reason of the varying shapes of the atoms. We need scarcely remark that the Atomists, in obedience to metaphysical and epistemological considerations, offer us only a refined method of smuggling in by a back door what they expelled with much ceremony at the front. As to the first theory, we are not to suppose that it belonged only to Empedocles, or that it was necessarily from him that the Atomists borrowed the conception on which they based their futile refinement. Aristotle himself would set us right, for he says³: 'Now the sapid juices found in pericarpal fruits evidently exist also in the earth. Hence many of the old natural philosophers assert that water has qualities like those of the earth through which it flows, a fact especially manifest in the case of saline springs, for salt is a form of earth. Hence also when liquids are filtered through ashes, a bitter substance, the taste they yield is bitter. There are many wells, too, of which some are bitter, others acid, while others exhibit other tastes of all kinds.'⁴

There remains one further point to note in connection with the mechanism of nutrition. We have seen that growth is explained on the principle of the accession of like to like, and that this addition is brought about as a result of the attraction of like for like. We have now to ask whether there was any attempt to account for this attraction. The answer is simple. It was due to the 'drawing' upward of the humors by the sun; for in all water there is heat, and this heat tends upward or sunward, thus causing the branches of the plant, in which the heat predominates, to grow in that direction, whereas the roots, in which the earthy elements prevail, tend downward by the affinity of like

¹ In the vague interval between the fixed form of the atoms and the kaleidoscopic changes they may produce by combination and arrangement much mystery could lie concealed. It was here that Aristotle found the only real point of departure among the pre-Socratics for his conception of potentiality (*δύναμις*, *δυνάμει* *δυν*).

² Cf. Alexander, *ad loc.* 68, 5 f., especially 18 f. and 23 f.

³ *De Sensu*, 441^a 30 f. Cf. p. 152, n. 1, above.

⁴ Cf. *Plut. Aet. Phys.* B, 912 B f.

for like.¹ The subject of attraction, although involved in our present discussion, lies somewhat aside from the main purpose of this study, and must be reserved for detailed consideration at another time.

The conception of nutrition which we have sketched must have taken shape in the medical schools, though based on homely observations of common men who viewed the world not through hazy metaphysical formulas but with the concreteness of the unsophisticated. The exigencies of prescribing diet and medicines inevitably led to a certain rationale to guide the physician in the choice of means to his end. The uniform principle which thus emerged was that like attracts like and like feeds like. It may be objected that ancient medicine generally proceeded on the allopathic principle, *contraria contrariis*;² but this, as we shall see, is not a negative instance, but an application of the dictum *ὁμοιον ὁμοίῳ*. For our purposes we may confine ourselves to the Corpus Hippocrateum, since it alone concerns us here. First we must assume the point of view of the physician. Just as there is in the cosmos a warfare of the elements, so is there also in the body of man.

¹ Aët. 5, 26, 4 (Diels, *Dox.* 439): (According to Empedocles, plants) αὖθις θάψαι δὲ ὑπὸ τοῦ ἐν τῇ γῇ θερμῷ διαιρούμενα ('in altum elatas,' Diels), ὥστε (restrictive, 'without ceasing to be') γῆς εἶναι μέρη καθάπερ καὶ τὰ ἐμβρυα τὰ ἐν τῇ γαστρὶ τῆς μήτρας μέρη· τοὺς δὲ καρποὺς περιττώματα εἶναι τοῦ ἐν τοῖς φυτοῖς ὕδατος καὶ πυρός. The best commentary on this report is Hipp. Π. φύσις παιδίου, 22 (7, 514 f. L.); cf. particularly καὶ <τὸ σπέρμα> βιώμενον ὑπὸ τῶν φύλλων (the cotyledons) μεθελσι τῆς δυνάμους (quality or qualitative ingredient) ἐς τὸ κάτω, ἥ ἐν αὐτῷ ὑπολείπεται (after the sun's heat has evaporated the lighter ingredients) διὰ τὴν βαρύτητα, and (p. 516) τὸ δὴ θερμαινόμενον ὑπὸ τοῦ ἡλίου ἐκζέει ἐς τὰ ἄκρα. The entire account starts from the discussion of the foetus. Since Empedocles was a physician it is possible that the general comparison was part of the medical tradition.

² Hipp. Ἀφορισμοί, 2, 22 (4, 476 L.): ἀπὸ πλησμονῆς ὁκόσα ἀν νοσήματα γένηται, κένωσις ἴηται, καὶ ὁκόσα ἀπὸ κενώσεως, πλησμονή, καὶ τῶν ἄλλων ἢ ὑπεναντίως. Ἐπειδήμ. 6, 5, 4 (5, 316 L.): ἔησις ἀντίνοον, μὴ ὁμονοεῖν τῷ πάθει. Π. φύσις ἀνθρώπου, 9 (6, 52 L.). Π. φυσίων, 1 (6, 92 L.) see the passage quoted above, p. 149, n. 5, and: ἐνὶ δὲ συντόμῳ λόγῳ, τὰ ἐναντία τῶν ἐναντίων ἐστὶν ἰήματα· ἱητρικὴ γάρ ἐστι πρόσθεσις καὶ ἀφαίρεσις, ἀφαίρεσις μὲν τῶν ὑπερβαλλόντων, πρόσθεσις δὲ τῶν ἐλλειπόντων· ὁ δὲ τοῦτ' ἀριστα ποιεῶν ἀριστος ἱητρὸς. Π. τόπων τῶν κατὰ ἀνθρώπου, 41 (6, 332 L.). Π. ἱερῆς νοῦσου, 18 (6, 394 f. L.): χρὴ δὲ καὶ ἐν ταύτῃ τῇ νοῦσῳ καὶ ἐν τῇσιν ἄλλῃσιν ἀπάσῃσι μὴ αὔξειν τὰ νοσήματα, ἀλλὰ σπεύδειν τρύχειν προσφέροντα τῇ νοῦσῳ τὸ πολεμώτατον ἐκάστη, καὶ μὴ τὸ φίλον καὶ σύνθεσ· ὑπὸ μὲν γὰρ τῆς συνηθείας θάλλει καὶ αὔξεται, ὑπὸ δὲ τοῦ πολεμίου φθίνει καὶ ἀμυνοῦται.

Health consists in the harmony or proper ratio of one element with another; disease is due to the disturbance of the balance, when one element overpowers another. Hence the physician is called in to restore harmony, which he accomplishes by going to the succor (*βοηθεῖν*) of the element that is in danger of succumbing. This he can do either directly, by feeding or strengthening the weaker combatant, or indirectly, by breaking the force of the stronger. As the character of the disease is determined by the extravagating element, either procedure may fitly be described as curing opposites by opposites. Strictly the action of medicine is the same as that of food. 'For¹ just as plants and seeds, when put into the earth, draw each that constituent present in the earth which is after its kind (and there are present there the acid, the bitter, the sweet, the saline, and every sort); first, then, each draws to itself that which is most after its kind, and thereafter also others: even so also do medicines act in the body.' This view is therefore quite consistent with the theory of nutrition as stated above.

There is, however, one statement which is not so easily disposed of, although it rests ultimately on the same principles. Hippocrates *Περὶ τῶν κατὰ ἀνθρώπον*,² develops the thought that disease and cure are equally produced by the giving of like or of the unlike, according to circumstances (*καίρως*). In the last resort all depends on the relation between the body and that which is administered to it. When food is given in right quantities the body is nourished in right measure, and masters the food; if too little or too much is given or otherwise violent changes occur in the diet,³ the food overmasters the body, and then fever sets in and the selfsame foods produce an effect opposite to that which is normal. Although it is impossible, because of the corrupt condition of the text, to determine the writer's thought in all particulars, the general drift of the argument is clear; and it is evident that the same principles are supposed to obtain in both cases, though the changed conditions cause the same substances to act differently on the body.

¹ Hipp. Π. φύσις ἀνθρώπου, 6 (6, 44 L.).

² 42-44 (6, 334 f. L.).

³ The clause ἢ ἄλλοιως μεταλλάξας κρατέηται in c. 43 is clearly corrupt; but it is impossible to emend it satisfactorily with our present means. For this, as for many other points in the text of Hippocrates, we must await the promised *Corpus Medicorum Graecorum*.

There is furthermore involved the old Greek conception of change effected by a disturbance of the balance of power (*ἐπικράτεια*). For when an element oversteps its limit it is lost, as in the tug of war; or, as Lucretius says, repaying Heraclitus in his own coin, 'whenever a thing changes and quits its proper limits, at once this change of state is the death of that which was before.'¹

The foregoing account of the process of nutrition shows conclusively that the principles were not laid down by any individual but were developed from popular conceptions by various thinkers who belonged to the long and honorable line of the medical tradition. We know a few, but evidently relatively few, names of individuals, and are enabled by the scanty ancient sources to assign to Alcmaeon and Empedocles² a few specific doctrines; but are we thereby justified in regarding them as the 'discoverers' or originators of these principles? Even if we possessed unimpaired the rich store of literature dating from the sixth and fifth centuries, which we know to have existed, we should still be liable to error; for we know that nothing is more difficult than to determine the source of widely current thoughts. The search for beginnings and 'inventions,' which flourished in the Alexandrine age, yielded the scattered data on which we are largely dependent; yet even with our limited means we can prove that large masses of literature were hardly examined³ with a view to discover what they might yield.

¹ I, 670 f., transl. Munro.

² It appears to be generally overlooked that Empedocles was himself a physician. A study of the fragments of his poems and of the various traditions regarding him would of itself lead us to class him as such. Even his *Καθαρμοί* point to the same conclusion: cf. Hipp. II. *ἐπεὶς νόσους*, I (6, 354 f. L.). But we have the express testimony of Satyrus (Diog. L. 8, 58) that he was a physician. He was probably the first of the notable *ιατροσοφισταί*. This would help to explain his relation to the older medical tradition, on the one hand, and to the Sicilian school of physicians and the later *ιατροσοφισταί*, on the other. Cf. Zeller, *Philosophie der Gr.* I b, p. 754, n.

³ Galen, *Comment. ad I. Hipp. de Nat. hom.* (15, 25 f. K.), speaking of Menon's *Iatrika*, says: τῶν δ' ἥδη διαφθαρμένων παντάπασιν, ἡ σφισμένων μὲν, οὐ θεωρηθέντων δ' αὐτῶν, τὰς γνώμας οὐκ ἠδύνατο γράψαι. [Diels, *Sitzungsberichte der Akad. der Wiss. zu Berlin*, 1893, I, p. 103, n. 1, proposed *γνωρισθέντων* for *θεωρηθέντων*; but the text is sound. It means 'mustered' or 'passed in review.'] If Menon disregarded much, it is clear that for us it is irretrievably lost, as Galen and our other sources were absolutely dependent upon him for the older medici except 'Hippocrates.'

In this respect the medical writers appear to have fared even worse than others, since it is probable that in the fourth century no one knew what Hippocrates had written. The works now current under his name were clearly for the most part *adespota*.

What we know of the philosophy of Anaxagoras leads us to regard him as a link in the chain we have been tracing. Aristotle, in a puzzling passage,¹ discusses the doctrine of Anaxagoras in conjunction with Anaximander and Empedocles, relating it to 'the universal dogma of the physiologers,' *e nihilo nil fit*. Consequently 'they thought that things must arise from elements pre-existing and actually present in that from which they spring, but imperceptible by reason of the minuteness of the particles.'² And they therefore said that everything entered into the composition of everything, because they saw everything springing from everything; but that things differed in appearance and went by different names, according to the ingredient which predominated³ in quantity in the mixture of infinite constituents. Nothing existed, they thought, absolutely and altogether⁴ white or black or sweet or flesh or bone, but that of which it had most, gave character to the thing.' Whether this statement was framed, as seems highly probable, to include Empedocles, and possibly Anaximander, it certainly does state in its main outlines the thought of Anaxagoras, and emphasizes the logical or metaphysical principle which constituted it a philosophy. But it was clearly a more concrete body of facts that suggested the doctrine, and we are able to determine with a high degree of certainty what those facts were. They were the familiar phenomena of nutrition and generation⁵ as interpreted by the thought of the time.

¹ *Phys.* I, 4. I cannot here discuss the questions which grow out of the grouping of Anaximander, Anaxagoras, and Empedocles together in a common statement. Certain phrases evidently include the Atomists as well.

² Cf. Anaxagoras, fr. 1 Diels; Hipp. II. *ἀρχαίης ἡτρικῆς*, 14 (1, 602 L.): *ἐν γὰρ ἀνθρώπῳ καὶ πικρὸν καὶ ἀλμυρὸν καὶ γλυκὺ καὶ ὀξύ καὶ στρυφνὸν καὶ πλάδαρον καὶ ἄλλα μυρία παντοίας δυνάμεις ἔχοντα, πλήθους τε καὶ ἰσχύος. ταῦτα μὲν μεμυγμένα καὶ κεκρημένα ἀλλήλοισιν οὔτε φανερά ἐστιν, οὔτε λυπτεῖ τὸν ἀνθρώπον· ὅταν δὲ τι τούτων ἀποκριθῇ (is segregated) καὶ αὐτὸ ἐφ' ἑωυτοῦ γένηται, τότε καὶ φανερόν ἐστι καὶ λυτεῖ τὸν ἀνθρώπον.*

³ Cf. Anaxagoras, fr. 12 Diels.

⁴ Cf. Anaxagoras, fr. 8 Diels.

⁵ See Anaxagoras, fr. 10 Diels, and Burnet, *Early Gr. Philosophy*², p. 303 f. *Lucr.* I, 881 f. offers the fullest statement.

There are certain points on which it is perhaps impossible to determine the precise thought of Anaxagoras ; but there can be no doubt that at the root of his system lies the primitive conception of qualities as concrete ingredients, actually present in the thing and by their accession or departure changing its character. The ingredients, imparted by the earth, which spring-water contains and to which it owes its taste and its wholesome or unwholesome action on the system ; the nutriment carried by the blood and deposited as 'flesh added to flesh'¹; and the seed, containing in a nut-shell, as we say, all that shall spring from it, and guaranteeing the permanence of the species and the similarity of offspring to parent, because it is in the most literal sense an *abstract* (ἀπόσπασμα) of the parent, being 'of his flesh and of his bones'; these are, indeed, as Gomperz says,² data of primitive man's conception of nature, and they explain the thought of Anaxagoras. It is not improbable that Empedocles shared the same view, referring chiefly to the properties of the elements when he said that fire, air, water, and earth constituted things ; for he was clearly so interpreted by Philistion and others of the Sicilian school of medicine,³ and the criticism of the supposed 'elements anterior to the elements' which Aristotle offers in *De Caelo*⁴ seems to presuppose this view. The difference between Empedocles and Anaxagoras thus lies essentially in the fact that the former postulated four qualities whereas the latter did not limit the number.⁵

Of the Atomists there is little need to speak. The 'seeds' of Anaxagoras were seeds also to them. It was the same demand to discover the end in the beginning, and the beginning in the end, that gave rise to both theories ; but whereas Anaxagoras naively saw the thing itself in the seeds, Democritus and Epicurus found there only its determining

¹ Arist. *de Gen. animal.*, 723^a 10: 'Ἀναξαγόρας μὲν γὰρ εὐλόγως φησὶ σάρκας ἐκ τῆς τροφῆς προσίεναι ταῖς σαρκί.'.

² *Griechische Denker*¹, I, p. 180: 'Damit war Anaxagoras zu der naiven Natur-auffassung des primitiven Menschen zurückgekehrt,' etc. Gomperz regards this as a serious indictment ; but that does not concern us here.

³ Diels, Anonym. *Londin.* 20, 25: Φιλιστίων δ' οἰεται ἐκ τῶν ἰδεῶν συνεστάναι ἡμᾶς, τοῦτ' ἔστιν ἐκ τῶν στοιχείων· πυρὸς, ἀέρος, ὕδατος, γῆς. εἶναι δὲ καὶ ἐκάστου δυνάμεις, τοῦ μὲν πυρὸς τὸ θερμόν, τοῦ δὲ ἀέρος τὸ ψυχρόν, τοῦ δὲ ὕδατος τὸ ὑγρόν, τῆς δὲ γῆς τὸ ἐρρόν. Cf. Wellmann, *Fr. der gr. Ärzte*, I, p. 69 f.

⁴ 3, 5, esp. 304^b 6 f.

⁵ See Zeller, *op. cit.* Ib, p. 980, n. 2.

cause. The account of Lucretius, which truthfully reproduces the thought of Democritus as well as of Epicurus, requires only the substitution of definite, qualitatively determined granules for the atoms, qualitatively homogeneous or indifferent, but determinate in size and shape, in order to apply with equal propriety to the theories of Empedocles and Anaxagoras.¹ And it is evident that the Roman poet was aware of the fact.

We have thus far considered the subject of nutrition only in its most general aspects; but Greek science was not content to leave the matter there. There can be no doubt that from the earliest times men, and particularly physicians, were aware of the principal stages of the process, such as the mastication of food by grinding between the molars, deglutition, distribution, and elimination; but it was not known just what took place in the stomach and the intestines, except that somehow the food was there prepared to perform the ultimate purposes of nutrition, the repairing of waste and the growth of the organism. Doubtless it was early known that animal heat was conducive to the successful disposal of nutriment, since in the absence of it the food remained to disturb the system.² The general view, which we have found so widely held, appeared to call for nothing more, and it is evident in particular that there was no special theory of 'digestion.'

It was probably Aristotle who first singled out digestion (πέψις) as a subject for special treatment. Others before him had, as we shall presently see, referred vaguely to foods as digested or undigested, but

¹ Lucr. I, 159-214. The argument, if accepted at its face value, presupposes the postulate of specific antecedents, virtually like those assumed by Empedocles or Anaxagoras. What Lucretius wishes to establish is the existence of atoms of specific shapes, which merely alters the form, not the substance, of the thought: cf. 190 f.: ut noscere possis | quidque sua de materia grandescere alicue. Only at v. 196 does a hint of distinctively atomistic thought occur. The same observation holds true of I, 803-829 and I, 865-920. The latter passage in particular shows that Lucretius was aware of the essential similarity of the doctrines of Epicurus (Democritus) and Anaxagoras. The parallel is perfect, except for the points noted. Lucr. I, 167 uses *genitalia corpora* in reference to the atoms; Ovid. *Met.* 15, 239, of the four elements: quattuor aeternus genitalia corpora mundus | continet. Everywhere we meet the *semina certa*, only in the Atomists the idea has lost its original force, which survives intact in the other corpuscular systems. Cf. also Lucr. 2, 546-568; 2, 865 f., 1156 f., and Giussani, *Lucreti Cari De R. N.*, II, p. 143 f.

² Hipp. *Ἀφορισμοί*, I, 14 (4, 466 L.); II. *διατρὴς ὑγιαυνῆς*, 7 (6, 82 L.); II. *φυσῶν*, 7 f. (6, 98 f. L.); II. *διατρὴς*, 3, 75 (6, 616 L.); II. *νούσων*, 42 (7, 562 f. L.). Cf. p. 151, n. 2 above, and Diels, *Anonym.* *Londin.* 5, 37 f.

no one had inquired narrowly into the implications of the conception. Previous opinion had been based upon simple observations and on the primitive notions of practical men: when, as in the case of Empedocles and Anaxagoras, logical or metaphysical principles were applied, they were of the simplest kind, like that of *e nihilo nil fit*, which were begotten of the same primitive notions. The Atomists alone had carried the question beyond this range of ideas, in that they substituted general causality for the specific antecedents in kind, thus interpolating a vague metaphysical term between the antecedent and the consequent. While Aristotle did not accept Atomism, he did seize the opportunity presented by this breach, and installed there two kindred conceptions, which are in fact the most characteristic ideas of his system: to wit, (a) the change of quality (*ἀλλοίωσις*) which occurs without addition to or subtraction from the material substratum, being a change from a qualitatively indifferent into a qualitatively determinate or from contrary to contrary, and (b) the development from a state of potentiality to a state of actuality.¹ This almost inseparable pair of conceptions he applied to digestion,² and accordingly distinguished food before digestion, which he regarded as 'opposite' in character to the organism, from digested food, that had become 'assimilated'³ to the organism in the process of digestion by the operation of the internal heat of the body.⁴ 'Heat causes growth,⁵ and fits the food-stuff for alimentation; it attracts [into the organic system] that which is light [viz. the sweet],⁶

¹ See above, p. 153, n. 1.

² *De Anima*, 416^b 3 f. The whole chapter should be consulted. See also *Meteor.* 379^b 18–380^a 6.

³ Aristotle himself does not use *ἐξομοιῶσθαι*, which subsequently became the technical term for the process; nor does he expressly apply the term *ἀλλοίωσις* to it, although he clearly indicates the conceptions in both cases. Thus Galen, 15, 237 K, says: *ὁμολογηται γὰρ . . . τὴν πέψιν εἶναι ἀλλοίωσιν καὶ μεταβολὴν τοῦ τρέφοντος εἰς τὴν οἰκίαν τοῦ τρεφόμενου ποιότητα*, and [Arist.] *Problem.* 907^a 18: *ἡ γὰρ πέψις ἀλλοίωσις ἐστὶ τοῦ πεττομένου*.

⁴ *De Anima*, 416^b 27 f.; *Meteor.* 379^a 18: *πέψις μὲν οὖν ἐστὶ τελείωσις ὑπὸ τοῦ φυσικοῦ καὶ οἰκείου θερμοῦ ἐκ τῶν ἀντικειμένων παθητικῶν κτέ.* Cf. also *de Gen. animal.* 753^a 19; 765^b 15; 786^a 17; *de Part. animal.* 650^a 3: *ἐπεὶ δ' ἀνάγκη πᾶν τὸ αἰξανόμενον λαμβάνειν τροφήν, ἡ δὲ τροφή πᾶσιν ἐξ ὑγροῦ καὶ ξηροῦ, καὶ τούτων ἡ πέψις γίνεταί καὶ ἡ μεταβολὴ διὰ τῆς θερμῆς δυνάμεως, κτέ.*

⁵ *De Sensu*, 442^a 4 f., transl. Beare.

⁶ Note the exact parallel to the cosmic process of *ἀναθυμίασις*.

while the salt and bitter it rejects because of their heaviness. In fact, whatever effects external heat produces in external bodies, the same are produced [by their internal heat] in animal and vegetable organisms.¹

This theory of digestion met with much favor, and was adopted and developed by many physicians of subsequent date. It is the doctrine defended by Galen and the dogmatic school, and therefore the casual reader would naturally suppose that it represents the whole medical tradition, especially since Galen with pardonable zeal, though with little historical sense, reads the orthodox view into Hippocrates and all the noble line of the 'ancients.' It would lead us too far afield if we should attempt to trace the history of the later Greek theories of digestion, a task for which the writer freely confesses that he is not prepared; but it is highly important for our subject to pursue the question somewhat farther. Before passing on to this inquiry it is perhaps worth while to remark that the seeming preponderance of authorities is no satisfactory criterion by which to judge of the relative standing of the rival theories of nutrition, since the survival of the extant medical works was obviously conditioned by their acceptability in the Middle Ages, when the sway of of the Aristotelian philosophy, with which they in the main agree, was complete. We are therefore prepared to discount their testimony.²

Celsus says³ that medical writers, considering the matter of digestion one of the greatest importance, devote their attention chiefly to it, and gives a resumé of the doctrines proposed on this head; the Empirical school, however, held that it mattered not how food was digested, but

¹ As Aristotle's philosophy, in spite of its failure to correlate certain doctrines, presents itself as a whole complete and essentially unchanged in all his works, we can discover no development within it. Hence it is impossible to say whether cosmic *ἀναθυμίασις* or physiological *πέψις* first appeared to him to involve *ἀλλοίωσις*; but it is interesting to note that he found his favorite principle in both processes.

* But the chance discovery of the Anonym. London. (cf. 24, 19 f.) may well caution us against going too far in the opposite direction.

³ *De Medicina*, I, *Prooem.* (4, 16 Daremb.): Ex quibus quia maxime pertinere ad rem concoctio [Gr. *πέψις*] uidetur, huic potissimum insistunt; et, duce Erasistrato, teri cibum in uentre contendunt; alii, Plistonico Praxagorae discipulo, putrescere; alii credunt Hippocrati, per calorem cibos concoqui: acceduntque Asclepiadis aemuli, qui omnia ista uana et superuacua esse proponunt; nihil enim concoqui, sed crudam materiam, sicut assumpta est, in corpus omne diduci.

what food was most nutritious.¹ From various sources we obtain similar catalogues, evidently derived from the medical doxographers.² Galen calls the roll of honor among the ancients,³ naming Hippocrates, along with Aristotle, as an exponent of his own theory of digestion.

Hippocrates, it is claimed, held that digestion (*πέψις*, in the meaning given to the term by Aristotle and Galen) is effected by the internal heat. It is true, as we have seen,⁴ that the heat of the body is here recognized as necessary to the proper preparation of food for the office

¹ *Ibid.* (7, 2 Daremb.): sed has latentium rerum coniecturas ad rem non pertinere; quia non intersit, quid morbum faciat, sed quid tollat, neque quomodo, sed quid optime digeratur, siue hac de causa concoctio incidat siue de illa, et siue concoctio sit illa siue tantum digestio. Note the use of terms. *Concoctio* is the equivalent of *πέψις* when applied to the process of nutrition, whereas *coctio* is used to render the word when it relates to pathological conditions; *digestio*, as its natural force suggests, is here employed to characterize 'digestion' considered merely as a process of comminution and separation of the food-stuff into its several constituents. Elsewhere (see following note) it is used as the generic term, including *concoctio* as well as *digestio* proper. In view of the fact that both *πέψις* (see following note) and *concoctio* could be used in a lax general sense, without implying anything as to the character of the process, it seems unaccountable, except on the basis of dogmatic prejudice, that Galen should hold that the definition of *πέψις* as *ἀλλοίωσις* was generally accepted (cf. p. 160, n. 3).

² Ps.-Soranus, *Quaest. Med.* 61 (*Anecd. Graeca et Graecolatina*, ed. Rose, II, p. 255): Quomodo Hippocrates et Erasistratus et Diocles et Genoetas (?) et Asclepiades philosophi digestionem cibi et potus fieri dixerunt? Hippocrates ab innato in nobis calore fieri digestionem dixit, Erasistratus vero teri et solvi [= digeri], Diocles autem putrescere, Genoetas a natura elimari [= λαινεσθαι], Asclepiades autem per exercitationem corporis fieri dixit. Ps.-Galenus, *Def. Med.* 99 (19, 372 K): τὰς πέψεις τῆς τροφῆς Ἱπποκράτης μὲν ὑπὸ τοῦ ἐμφύτου θερμοῦ φησι γίνεσθαι, Ἐρασιστράτος δὲ τρίψει καὶ λειώσει καὶ περιστολῇ τῆς γαστρὸς καὶ ἐπικτήτου πνεύματος ἰδιότητι. Ἐμπεδοκλῆς δὲ σήψει· οἱ δὲ ἐξ ὧμων ἔφασαν τὰς ἀνάδους γίνεσθαι, ὥσπερ καὶ Ἀσκληπιάδης ὁ Βιθυνός.

³ Galen, Π. φυσικῶν δυνάμεων, 2, 8 (2, 118 K): περὶ δὲ τῶν χυμῶν γενέσεως οὐκ οἶδ' εἰ ἔχει τις ἕτερον προσθεῖναι σοφώτερον ὢν Ἱπποκράτης εἶπε καὶ Ἀριστοτέλης καὶ Πραξαγόρας καὶ Φιλότημος καὶ ἄλλοι πολλοὶ τῶν παλαιῶν. ἀποδείκνυται γὰρ ἐκεῖνοις τοῖς ἀνδράσιν ἀλλοιούμενης τῆς τροφῆς ἐν ταῖς φλεβῖν ὑπὸ τῆς ἐμφύτου θερμότητος αἷμα μὲν ὑπὸ τῆς συμμετρίας τῆς κατ' αὐτήν, οἱ δ' ἄλλοι χυμοὶ διὰ τὰς ἀμετρίας γιγνόμενοι· καὶ τοῦτ' ὡς λόγῳ πάντ' ὁμολογεῖ τὰ φαινόμενα. For Hippocrates, see also *ibid.*, I, 12 (2, 30 K). Regarding Praxagoras and Philotimus we are not in a position to judge the correctness of Galen's statement. Probably, however, their views coincided generally with that of 'Hippocrates.'

⁴ P. 159, n. 2, above.

of alimentation; but there is no trace of the distinctive conception which we find in Aristotle. So far as one may judge, heat was regarded as furthering the nutritive process much as cooking the food-stuff facilitates it.¹ The change effected is merely that of rendering the substances more readily digestible.² The amount of nutriment ingested has much to do with the proper disposal of it; if an even (equal) amount is taken, the body is evenly nourished, since it 'masters' the food; if it varies, the food masters³ the body, and the normal balance is disturbed to the detriment of health. Galen was particularly impressed with the supposed agreement of *Περὶ τροφῆς*⁴ with himself in regard to nutrition. To be sure he did not always regard the tract as the work of Hippocrates,⁵ but he was clearly overjoyed to discover his favorite conception so plainly, as he thought, anticipated by the author.⁶

¹ I do not find this expressly stated, but it is clearly implied, in Hippocrates; Aristotle, however, who in many respects merely developed the thought of the earlier medical tradition by introducing distinctions and auxiliary conceptions foreign to his predecessors, elaborates the comparison *Meteor.* 381^a 9: ἡ μὲν οὖν κατὰ τὴν ἔψησιν λεγομένη πέψις τοῦτ' ἐστίν· καὶ οὐδὲν διαφέρει ἐν ὀργάνοις τεχνικοῖς ἢ φυσικοῖς, ἐὰν γίνηται· διὰ τὴν αὐτὴν γὰρ αἰτίαν πάντα ἔσται, adding the 'Hippocratean' observation that art merely imitates nature, *ibid.*, 381^b 6: μιμείται γὰρ ἡ τέχνη τὴν φύσιν, ἐπεὶ καὶ ἡ τῆς τροφῆς ἐν τῷ σώματι πέψις ὁμοία ἐψησει ἐστίν.

² Π. τροφῆς, 49 (9, 118 L.): ὑγρὴ τροφή εὐμετάβλητος μᾶλλον ἢ ξηρή· ξηρὴ τροφή εὐμετάβλητος μᾶλλον ἢ ὑγρὴ· ἡ δυσαλλοίωτος δυσεξανάλωτος, ἡ εὐπρόσθετος εὐεξανάλωτος. The meaning of this is made clear by c. 51 *ibid.*: μῆες (muscular tissues) στερεώτεροι δυσέκτηταί <μᾶλλον> τῶν ἄλλων, παρὲξ ὅστέον καὶ νεύρου· δυσμετάβλητα τὰ γεγυμνασμένα, κατὰ γένος αὐτὰ ἐωνυῶν ισχυρότερα ἐόντα, διὰ τοῦτο αὐτὰ ἐωνυῶν δυστηκτότερα.

³ Hipp. Π. τόπων τῶν κατὰ ἄνθρωπον, 43 (6, 336 L.). See above, p. 155.

⁴ 9, 98 f. L.

⁵ The scholion at the beginning of Π. τροφῆς (adnot. 9, 98 L.) says: τοῦτο σύγγραμμά φησιν ὁ Γαληνὸς μὴ εἶναι Ἱπποκράτους, πλὴν ἄλλ' οὐδὲ παλαιοῦ του τυχεύοντος σοφοῦ (so far probably we have to do with Galen; the following guesses belong to other authors), καὶ ἴσως εἴη τοῦ Θεσσαλοῦ· δοκεῖ δὲ ὑπὸ Ἡροφίλου συγχεῖσθαι. In his commentary on the treatise Galen (15, 220 f. K.) everywhere assumes that it is both 'ancient' and Hippocratic. Similar diversities of opinion on the part of Galen are met with in regard to other members of the Corpus Hippocrateum.

⁶ It were useless to cite the expressions of Galen which show that he interpreted the treatise as in accord with Aristotle. The difference is indeed slight in compass, so to speak, but what is lacking in Hippocrates is the doctrine of ἀλλοίωσις and ἐξομώσις. Aristotle clearly derived his general doctrine from this treatise and others like it, such as those cited below in illustration of the text.

In order to be able to judge of the truth of this contention, we may best present the relevant passages. (c. 2) 'Nutriment increases and strengthens and adds flesh and maintains and changes the constituents of the several parts of the body according to the constitution of each member and its original quality (or constituent). (c. 3) It maintains the organism in constitution and quality when the nutriment ingested is mastered¹ and the nutriment already in the body prevails.² (c. 4) Sometimes the nutriment previously ingested, sometimes the later-coming nutriment, becomes in time weak (i. e., overpowered) by being discharged or added to.³ (c. 5) Both alike are enfeebled in time and after a lapse of time, both by the continuous ingestion of nutriment from without and by food that remains long⁴ solidly fixed in all the members (the system). (c. 6) And it produces⁵ its own kind, but changes the former nutriment and is carried off; sometimes, however, it enfeebles the previously ingested nutriment and nutriment taken even earlier.⁶ (c. 8) Nutriment (is used in different senses: it) means now that which is nourishing the organism, now that which is of a kind to serve as nutriment, now that which is presently to nourish the system.'

A disinterested study of these pronouncements yields the result that Galen was not justified in interpreting them as presenting the Aristotelian doctrine of digestion. Littré was quite right in saying that the Hippocratics knew, so to speak, only the beginning and the end of the

¹ Read *κρατέται* here for MS. *κρατέη*. Since I perceived the necessity of this change I have noted two other scholars who propose it.

² Cf. II. *διατρης ὑγιεινῆς*, 7 (6, 82 f. L.); II. *φυσέων*, 7 (6, 98 f. L.); II. *διατρης*, 3, 74 (6, 614 f. L.); II. *νούσων*, 4, 42 f. (7, 562 f. L.).

³ Cf. II. *τόπων τῶν κατὰ ἀνθρώπον*, 42-44 (6, 334 f. L.). The use of *ἐξίτηλος* = 'weak' deceived Galen and Littré: *γίνεται ἐξίτηλος* simply = *ἀμαυροῦνται*; cf. c. 5 and above, p. 154, n. 2.

⁴ Cf. II. *φυσέων*, 7 (6, 100 L.).

⁵ *ἐξεβλάστησε*, which Littré renders 'rejette sa propre forme.' The word seems, however, to be most naturally taken as above; cf. c. 54 (9, 120 L.): *δύναμις* ('quality or qualitatively fixed ingredient of food'?) or, as Littré says, 'la force, c'est-à-dire la propriété par laquelle le corps s'assimile l'aliment'?) I incline to the former view) *πάντα αὖξει καὶ τρέφει καὶ βλαστάνει*. The meaning here given to *δύναμις* is of course common in Hippocrates, and seems to accord best with the following, and final, words of the treatise: *ύγρασίη τροφῆς* (i. e., *δυνάμεων*) *εχρημα*.

⁶ I here omit *ιδὲν ἐξάλλαττει* with the vulgate. The general sense of the passage is perhaps best illustrated by II. *νούσων*, 4, 42 (7, 562 f. L.).

process of alimentation;¹ of digestion (πέψις) in the narrower sense, implying the conversion (ἀλλοίωσις) of potential into actual nutriment, they knew nothing, and advanced no theory to account for it. This conclusion is supported by the report we receive of the doctrines of Aegimius² (probably a contemporary of Hippocrates), of Diocles,³ and of Plato. Plato is particularly clear in his exposition, and shows that the view, which we have characterized as that of the pre-Socratics generally, was expressly formulated.⁴ His use of the conception of fermentation or putrefaction likewise shows, if, indeed, the occurrence of the notion in Empedocles were not sufficient proof, that this process also

¹ *Œuvres Complètes d'Hippocrate*, 9, 94: 'Les hippocratiques ne connaissaient, quant à l'aliment, que les deux termes extrêmes: ils savaient qu'il était introduit dans le canal digestif et assimilé à chaque partie, devenant os dans les os, muscle dans les muscles, veine dans les veines, et ainsi du reste. Mais toutes les opérations intermédiaires leur étaient inconnues.' The words italicized are due to his acceptance of the interpretation of Galen, which I believe has been shown to be unfounded.

² Diels, Anonym. Londin. 13, 40: φησιν δὲ τρέφεσθαι τὰ σώματα ὑπὸ τῆς νεαρᾶς καὶ ἀπέπτου τροφῆς, γενηθείσης δὲ τῆς πέψεως καὶ ἀναδόσεως κενοῦσθαι τὰ ἀργεῖα καὶ τὰς διεξόδους. These words are a part of the excerpts from Menon's *Iatrika*, and well illustrate the doxographic method. First it is stated that nutrition is accomplished by 'fresh and (in the Aristotelian sense) undigested' food; then mention is forthwith made of digestion (πέψις) in the untechnical sense. As Diels (in the Index, s. v., to Anonym. Londin.) is probably right in calling Aegimius 'aequalis fere Hippocratis,' it follows that the report has been accommodated to the controversy started by Aristotle.

³ See Wellmann, *Fr. der gr. Ärzte*, I, p. 85 f.

⁴ *Tim.* 78 E: ὁπότεν τὸ πῦρ . . . διὰ τῆς κοιλίας εἰσελθὼν τὰ σιτία καὶ ποτὰ λάβῃ, τήκει ('dissolves') δὴ, καὶ κατὰ σμικρὰ διαιροῦν . . . 80 D: τέμνοντος μὲν τὰ σιτία τοῦ πυρὸς, αἰωρουμένου δὲ ἐντὸς τῷ πνεύματι ξυνοπομένου, τὰς φλέβας τε ἐκ τῆς κοιλίας τῇ ξυναωρῇσει πληροῦντος τῷ τὰ τετμημένα αὐτῷθεν ἀπαντλεῖν' καὶ διὰ ταῦτα δὴ καθ' ὅλον τὸ σῶμα πᾶσι τοῖς ζώοις τὰ τῆς τροφῆς νάματα οὕτως ἐπύρρυντα γέγονε. νέοτμητα δὲ καὶ ἀπὸ ξυγγενῶν ὄντα . . . πανταδαπὰ μὲν χρώματα ἴσχει διὰ τὴν ξύμμειν, ἥ δ' ἐρυθρὰ περὶ αὐτὸ χροὰ διαθεῖ, τῆς τοῦ πυρὸς τομῆς τε καὶ ἐξομόξεως ἐν ὑγρῷ δεδημιουργημένη φύσις . . . 81 A: ὁ δὲ τρόπος τῆς πληρώσεως ἀποχωρήσεως τε γίνεταί, καθάπερ ἐν τῷ παντὶ παντὸς ἡ φορά γέγονεν, ἣν τὸ ξυγγενὲς πᾶν φέρεται πρὸς αὐτὸ κτέ. down to 81 E. In view of the general agreement of Diocles and Plato and their dependence on the same authorities or authority (Wellmann thinks it was Philistion), this clear-cut statement is doubly important. Fire works no inner change (ἀλλοίωσις), but merely comminutes the food and so prepares it for absorption and distribution by the blood.

involved nothing inconsistent with the purely mechanical theory of nutrition generally current up to the time of Aristotle.¹

It is not our purpose at this time to follow the conception of Aristotle through the later period of Greek thought; but it is noteworthy that two of the foremost physicians in their time, Erasistratus and Asclepiades of Prusa, definitely repudiated it. We have seen that Aegimius was reported to have said that the body was nourished by 'fresh and undigested' food; but our account has shown that this must be a mere inference from what he actually said, since there was no theory of digestion then in existence that called for a specific denial. In all probability Aegimius merely said, as did the entire early medical tradition, that like nourished like, expressly emphasizing this fact much as we see it presented by Plato. But with Erasistratus and Asclepiades the case was different. The former was closely associated with Theophrastus, who, as the successor of Aristotle in the Lyceum, adhered to his doctrine. When, therefore, Erasistratus rejected the Aristotelian conception of digestion, he must have done so advisedly and expressly. That Asclepiades deliberately and in express terms repudiated the view is clear from the records.²

Now this fact is of great importance for the history of the post-Aristotelian corpuscular theories. In the case of Asclepiades we can prove with absolute certainty that the rejection of the Aristotelian conception of digestion was only a symptom, so to speak, of his thought as a whole; for it was intimately connected with his doctrine of the 'fragile molecules' or *ἀναρμιοὶ ὄγκοι*. Since we have elsewhere proved this,³ the case need not here be restated. But other conclusions at once suggest themselves. The *ἀναρμιοὶ ὄγκοι* are possessed of indefeasible qualities,

¹ See Wellmann, *l. c.*, for *σῆψις* and *ζύμωσις*. I believe that 'decay' and 'fermentation' were understood only as a process of dissolution of the organic compound into its constituent parts, which were thus prepared for the function of nutrition by the accession of like to like. Yet the instances I have gathered of the use of *σῆψις* indicate that we have here a very important conception in medical circles, which well deserves further investigation.

² For Erasistratus and Asclepiades, see above, p. 161, n. 3, and p. 162, n. 2, and my article, *The ἀναρμιοὶ ὄγκοι of Heraclides and Asclepiades*, in *Trans. Am. Phil. Assoc.* XL (1910), p. 8, n. 3. For a full statement of the views on digestion of the two principal medical 'schools' after Aristotle, see Galen, II. *φυσικῶν δυνάμεων*, I, 11 f. (2, 25 f. K.).

³ See the article referred to in the preceding note.

and they are infinitely divisible, being separated and divided by 'pores so minute as to be apprehended only by the reason,' and from all things there is flowing an unintermittent stream of effluvia. In all this we recognize the thought of the pre-Socratic medical tradition, and of Empedocles and Anaxagoras. We should perhaps be inclined to doubt this conclusion if Asclepiades stood alone; but we see that in one particular, that is in regard to the theory of digestion, the gap between Asclepiades and Plato is filled by Erasistratus, which of itself suggests a true succession in the line of the medical tradition. But we are happily able to supply other links which likewise point to the medical tradition as the intermediary between Anaxagoras and Asclepiades; for the originator of the name, and doubtless of the theory, of the *ἀναρροί ὄγκοι*, was Heraclides of Pontus, a contemporary of Aristotle and associated alike with him and with Plato. The interest of Heraclides in medicine is attested by the catalogue of his writings,¹ and it is fairly certain that he was acquainted with the somewhat younger Erasistratus.

There is, moreover, another link in the chain; Strato, second in succession to Aristotle in the headship of the school, and the most scientific master of the Peripatetics, supplies, as it were, all the clues necessary to guide one through the tangled maze. Since Diels, by utilizing the introduction to Hero's *Pneumatica*, recovered in large part the physical philosophy of Strato,² at least in outline, we are able to detect the connection between it and the medical principles of Erasistratus. Diels here apparently sees only the debt of Erasistratus to Strato, not perceiving that the thought of the latter harks back at almost every important point to the assumptions and conceptions due to the older medical tradition; even where Strato agrees with Aristotle, the emphasis and point of view seem to be those of the fifth century. Like most leaders of thought in the third century, Strato obviously revolted against the dominion of metaphysics in which Aristotle ruled supreme, and felt himself akin in spirit to the pre-Socratics. The so-called 'qualities' (*ποιότητες*,³ *δυνάμεις*) of Strato have no affinity with

¹ Diog. L. 5, 87, mentions *Ἀτρίαι περὶ νόσων α'*.

² Diels, *Über das physikalische System des Straton*, *Sitzungsb. der Berl. Akad.* 1893, I, p. 101 f.

³ See Diels, *op. cit.*, p. 112, n. 2. Zeller, *Phil. der Gr.*, II^b, p. 907, regards the *δυνάμεις* as 'die diese Eigenschaften bewirkenden Kräfte,' but he is in error; they are just the *ποιότητες* under the old name, familiar from Hippocrates.

the metaphysically or logically conceived qualities of Aristotle, which play like unreal shadows over an abstract mathematical figure, but are rather, like the 'fragile molecules' of Heraclides,¹ or the homoeomerics of Anaxagoras, or the 'elements anterior to the elements' of Empedocles, divisible granules of matter possessing indefeasible properties, such as the older medical tradition employed to explain the phenomena of nutrition and the permanence of species. In a word, they were *semina certa*. Like Heraclides, Strato engaged in a polemic against the atomism of Democritus.² It is greatly to be regretted that we do not learn here what arguments they brought to bear upon the theory. They may have contented themselves with repeating those already advanced by Aristotle, but it is not impossible that they added others of a physiological order, since their own hypotheses were found to be especially welcome to physicians. The 'elements,' i. e., the fundamental qualities, postulated by Strato, we are told,³ were the warm and the cold. Herein he agreed with Aristotle, but for the latter the doctrine had little significance. In the Hippocratic literature, however, the hot and the cold play a prominent part.⁴ Like Aristotle, again, Strato denied the existence of a void in the sense of the Atomists: he refused to admit a continuous void (*ἀθροῦς κενὸς τόπος*), but assumed the presence of minute interstitial empty spaces.⁵ In this, it would seem, Asclepiades agreed with him, although the precise doctrine of the much maligned physician is in this, as in many other respects, difficult to determine, because we know him only from references in unintelligent or prejudiced authors. In regard to Strato's theory of the interstitial void we have only the arguments belonging to mechanics and the physical theory of light; but it is altogether probable that he applied the theory to explain not only the problems of hydrostatics and the absorption or diffusion of light, but also that of suction in suction pumps and in the circulatory

¹ Diels, *op. cit.*, p. 112, n. 4, likewise notes the similarity.

² For Heraclides, see Diog. L. 5, 87, who mentions among the *φυσικά* a work entitled *Περὶ εἰδῶλων πρὸς Δημόκριτον*; for Strato, see Diels, *op. cit.*, p. 112, n. 1.

³ Stob. *Ecl.* I, 298: *Στράτων στοιχεῖα τὸ θερμὸν καὶ τὸ ψυχρὸν*. Cf. Zeller, *op. cit.*, II^b, p. 907, n. 7.

⁴ Cf. Fredrich, *Hippokratische Untersuchungen*, p. 134 f.

⁵ See Diels, *op. cit.*, p. 104 f., who points out the debt of Erasistratus to Strato in this particular.

system of the human body. If the latter be true, as it appears to be, we must connect with the acceptance of 'dispersed' void the circular system of alimentation and respiration, which Strato adopted from the old medical tradition as transmitted by Diocles,¹ Plato, and Aristotle. Essentially this theory is an exemplification of the ancient tug-of-war between the elemental hot and cold, in which the void created by the retirement of one contestant is closed by the hot pursuit of the other (ἀκολουθία πρὸς τὸ κινούμενον). All this points clearly to a lively interest in medicine, which is borne out by the titles of works ascribed to Strato, such as his treatise *On Diseases* and *On Alimentation and Growth*.

We have devoted so much space to the subject of nutrition, not only because the history of the conceptions involved in it has not been written, but also because the process has the greatest significance for the corpuscular theories of the Greeks. Intimately connected with alimentation are several other physiological subjects which can here receive only a passing notice. We have repeatedly remarked that the principle of *semina certa* was invoked not only by those who adhered to the conception of the medical tradition, that like feeds like, in the most literal sense, but also by the Atomists, whose atoms are 'determinate seeds' in quite a different way. The principle *e nihilo nil fit*, as we have seen, also appeals to the fact that like begets like; and from early times it was common to speak of the 'elements' or 'principles' of things as 'seeds,' or to use a Lucretian phrase, as *genitalia corpora rebus*. The development of cosmology or cosmogony out of 'theology' or theogony may be held in part to explain such forms of expression; but we must not forget that primitive modes of thought persist in slightly varying disguises even where one is least prepared to find them. To the Greek, except where the Socratic teleology prevailed, a thing was regularly defined with reference to its antecedents, i. e., with reference to its 'elements' or its constitution, viewed as the result of a process of composition.² Aristotle well illustrates the different points of view in a concrete case when he says:³ 'We must state the matter in a way

¹ See Wellmann, *Fr. der gr. Ärzte*, I, p. 42 f.

² See my study, *Περὶ Φύσεως*, *Proc. Amer. Acad. of Arts and Sc.* XLV, p. 79 f.

³ *De Gen. animal.* 725^a 21 f.

exactly opposite to that of the ancients; for they said that the seed is that which is derived from the entire organism, whereas we shall say that it is that which is so constituted as to pass into every part.'

The nature of the seed and of the reproductive process and the problems of embryology¹ were apparently always closely associated by the Greeks with alimentation; and the same principles were felt to apply in all. Not to refer to less important evidence,² it is sufficient to consult Aristotle's discussion of the nature of seed in *De Generatione animalium* I, 17 f. The view which he attributes to 'the ancients' is that seed is contributed by both sexes and that it comes from all parts of the body, just as food is disseminated throughout the body. Now we know that this opinion was held by Alcmaeon, Parmenides, Empedocles, and perhaps by Anaxagoras;³ even if Anaxagoras did not believe that the female contributed seed, there can be no doubt that he regarded the seed as proceeding from the entire male body. Now it is worthy of remark that Empedocles did not originate this doctrine, which is a strict corollary to that of the nutrition of like by like, but that we can trace it back to Parmenides and Alcmaeon. It is hard to believe otherwise than that these closely related principles formed a part of the medical tradition which Empedocles, as a physician, received from the schools or guilds. This conception of the seed was employed to explain the similarity of offspring to parent and even the inheritance of acquired characteristics.⁴ In his discussion of this theory Aristotle makes a statement which discloses the relation of the problems, at least as he saw it. 'This view,' he says,⁵ 'appears to resemble that of Anaxagoras, that none of the homoeomeries originates; except that he generalizes the principle, whereas these men apply it only to the generation of animals. Moreover, how shall these elements which flow from the entire organism grow? For Anaxagoras, in conformity with his theory, says that flesh is added to flesh from the food.' Aristotle thus clearly indicates that there were those who considered the problem merely from the

¹ Cf. Hipp. II. *φύσις παιδίου*, 17 (7, 496 f. L.).

² See Wellmann, *op. cit.*, I, pp. 51-54, and Diels, *Anonym.* Londin. 25, 41 f.

³ See Friedrich, *op. cit.*, p. 126 f.

⁴ Cf. Hipp. II. *ἀέρων, ὑδάτων, τόπων*, 14 (2, 60 L.), the case of the *Μακροκέφαλοι*, and Arist. *de Gen. animal.* 721^b 28 f.

⁵ Arist. *ibid.*, 723^a 6 f.

point of view of physiology, and did not, like Anaxagoras, translate the special conception in terms of a general philosophical principle. Whom he had in mind we do not know, but we naturally think of such as Parmenides and the medical fraternity.¹

We have already too long tarried with the subjects under consideration. Yet we must not drop them altogether without adding a few words regarding their significance. Unless our efforts have been altogether in vain, we may say, with Lucretius, from the point of view disclosed in the primitive conceptions of the Greeks, *corporibus caecis igitur natura gerit res*. Much that has been said above may be questioned, but it will be difficult to maintain that Empedocles and Anaxagoras, or even Heraclitus, introduced the ideas upon which the corpuscular theories are founded. It matters little in fact who first spoke of effluences (*ἀπρροαί*) or molecules (*ὄγκοι*): even if we could trace these terms to their source, we should not have reached the beginnings of the conceptions. These lie in the dateless age before the birth of history.

We have said little about the other cardinal postulate of the Atomists, the void. Every student knows that this conception is not primitive, but had its origin in a determined effort to meet a metaphysical objection, and hence is itself metaphysical. As such it falls outside the range of our present study, and might be disregarded altogether were it not that it had antecedents of a primitive character. The processes of evaporation, respiration, nutrition, and generation, which we have been studying, presuppose and postulate not only a corpuscular, but also a porous constitution of things. It is not without interest, therefore, that the very term 'pores' (*πόροι*) can be traced back to the sixth century; for we find it in Alcmaeon, and the scope it already had in his thought indicates that it can hardly have originated with him. The facts adduced by Lucretius to prove the existence of a void were with few exceptions known to primitive man, although not interpreted as the Epicurean interprets them. Aristotle also, in enumerating the considerations that led the Atomists to postulate a void, mentions the facts of nutrition and growth. 'Furthermore,' he says,² 'growth is regarded by

¹ See Hipp. II. *νόσων*, 4, 32 (7, 542 L.); II. *γυναικείων*, 1, 24 (8, 62 f. L.); and Wellmann, *Fr. der gr. Ärzte*, I, p. 35, n. 2.

² Arist. *Phys.* 4, 6, 213^b 18 f. Cf. *de Gen. et Corr.* 1, 8, 325^a 34-^b 5; Hipp. II. *τροφῆς*, 7 (9, 100 L.); Lucr. 1, 350 f.

all as taking place through a vacuum ; for they say that nutriment is corporeal and that two bodies may not occupy the same space at the same time.' We should clearly overvalue Aristotle's words if we accepted them as strictly true ; but we may safely conclude from them that the Atomists did appeal to the facts in question in support of their assumption.

If we accept the conclusion to which our study points, many questions hitherto much debated may henceforth be disregarded, or at least they must be restated. Thus the arguments pro and con, touching the priority of Empedocles or Leucippus in regard to the pores, fall to the ground, and with them most of the considerations which have been urged to establish a more intimate relation between these philosophers and Anaxagoras. A question much more profitable arises, however, in the older one's stead, viz., whether there are not in the Atomic theory a number of conceptions which ill fit into the general theory and owe their presence there only to historical reasons, or are in other words mere illogical survivals from older theories. If this should prove to be the case, as it appears to be, it would have a direct bearing on the chronological problem, and possibly on the mooted question whether Leucippus, a contemporary of Empedocles, or Democritus, a younger contemporary of Socrates, originated the Atomic theory. *Εἰς αὐθις τοίνυν· νῦν γὰρ σπεύδω ποι, καί μοι ἄρα ἀπιέναι.*